7th Annual CMMI Technology Conference & User Group

"Investigation, Measures and Lessons Learned about the Relationship between CMMI® Process Capability and Project or Program Performance"

Denver, Colorado

November 12 - 15, 2007

MONDAY, NOVEMBER 12, 2007

- CMMI V1.2 -- An Overview Mr. David Phillips, SEI

TUESDAY, NOVEMBER 13, 2007

State of CMMI®

- Mr. Clyde Chittister, Chief Operating Officer, SEI

Executive Panel

Panelists:

Ms. Kristen Baldwin, Office of the Secretary of Defense
Mr. Tom Neff, Defense Threat Reduction Agency
Mr. Rich Frost, General Motors

Lunch with Guest Speaker

- Mr. Mark Schaffer, Director, Systems & Software Engineering, OSD (AT&L)

Technical Sessions

TRACK 1

- When the Only Tool You Have is a Hammer, Every Problem Begins to Look Like a Nail, Mr. Sam Fogle, ACE Guides, LLC
- The Journey to CMMI Level , Mr. Andrew Lay, Lockheed Martin Aeronautics Company
- Visualizing Improvement with Capability Waypoints, Mr. Robert Jacob,
  Naval Air Systems CommandInstitutionalization Measures: Key to Improved Process Monitoring, Dr. John Rusnak, Lockheed Martin Space Systems Company

TRACK 3

- Assuring Quality for Efficient & Sufficient Testing Mr. Pramod Varma, Wipro Technologies

TRACK 4

- Bridging Process Improvement During Program Management Evolution: An Experience Report Capt DeWitt Latimer, USAF
- An "Embedded SCAMPI-C" Appraisal at the National Security Agency. Mr. Joseph Wickless, SEI

TRACK 5

- Linking Project Performance to CMMI Process Capability through Lean Measurements, Mr. Jeffrey Dutton, Jacobs Technology
- Quantitative Models for Predicting Project Success, Dr. Rick Hefner, Northrop Grumman Corporation

TRACK 6

- How to Kick Start a Process Improvement Effort to Achieve a CMMI Rating, Ms. Brenda Hall, Computer Sciences Corporation
- SEI Appraisal Program Quality Report, Mr. William Hayes, SEI
- The Process In-execution Review (PIER) After Three Years, Mr. Dale Swanson, The MITRE Corporation
- I'm Preparing My Organization for an Appraisal, but I'm Not Really Sure I Understand this PIID Thing. Should I Worry?, Mr. Sam Fogle, ACE Guides, LLC

TRACK 7

- Aligning CMMI and ITIL – Where Am I and Which Way Should I Go, Mr. Pat Mitryk, Cognence, Inc
- Integrated System Framework: A Way Out of the Multi-Model Madness, Mr. Paul Byrnes, Integrated System Diagnostics

WEDNESDAY, NOVEMBER 14, 2007

Lunch with Guest Speaker

- Ms. Mary Poppendieck, President, Poppendieck, LLC

Technical Sessions

TRACK 1

- CMMI Contenders, CMMI Pretenders, Dr. Rick Hefner, Northrop Grumman Corporation
- Initial Fears of CMMI Introduction and How Things Really Played Out, Dr. Paul Nugent, General Dynamics Advanced Information Systems
- Software Firm + CMMI Level 2 Initiative + 15 months = Dramatic Quality Improvements, Mr. Jeff Simpson, Campus Management Corporation
- How to Explain the Value of Every CMMI Practice, Dr. Rick Hefner, Northrop Grumman Corporation
- Mrs. Doubtfire Answers Your Questions about Process Improvement, Dr. Rick Hefner, Northrop Grumman Corporation
- Developing a Second Generation Directive System Architecture, Mr. Kenneth Weinberg, Raytheon Company
- Whose Processes Are These, Anyway, Ms. Judith Tejan, AAI Services Corporation
- Scientific Breakthroughs in Process Improvement, Ms. Cheryl White, Change Delivery Group

TRACK 2

- The What, When, Why and How for CMMI Training, Mr. Tom Bragg, AVISTA Incorporated
- Transitioning to the CMMI: What They Never Told You, Mr. Steve Fried, The Boeing Company
- CMMI Implementation: Overcoming the PPQA Challenge, Mr. Pat Mitryk, Cognence, Inc.
- How to Measurably Improve Your Requirements, Mr. Timothy Olson, Lean Solutions Institute, Inc. (QIC)

TRACK 3

- Using Lean Six Sigma to Implement CMMI High Maturity Practices, Ms. Beth Clark, Lockheed Martin
- The Potential for Lean Acquisition of Software Intensive Systems, Mr. Jeffrey Dutton, Jacobs Technology
- Lean, CMMI and Six Sigma Working Together to Achieve High Success, Ms. Susan Bassham, US Army Aviation and Missle Command
- Comparing and Contrasting the PP & PMC Process Areas of CMMI v 1.2 and SCRUM, Dr. Aldo Dagnino ABB, Inc. - US Corporate Research
- Effective Systems Engineering: What's the Payoff for Program Performance?, NDIA Systems EngineeringsEffectiveness
- What's All this 'churn' in Systems Engineering Standards and Models!?, Mr. Donald Gantzer, SAIC

TRACK 4

- Driving Process Improvement Using the CMMI-ACQ at General Motors, Dr. Richard Frost, General Motors
- Leading Indicators for Acquisition Programs, Mr. Robert Ferguson, SEI
- CMMI High Maturity Misconceptions, Mr. William Hayes, SEI
- High Maturity: How Do We Know?, Dr. Mike Konrad, SEI
- High Maturity System/Software Cost Estimation, Dr. Richard Welch, Northrop Grumman Corporation
- ADVANCE - Implementing a Defect Model for Performance Prediction, Mr. Stanley Martin, L-3 Communications/IS
- Statistically Managing a Critical Logistics Schedule Using CMMI, Mr. Robert Tuthill, Northrop Grumman Corporation
- A More Practical Set of High Maturity Practices, Dr. Rick Hefner, Northrop Grumman Corporation

TRACK 5

- Program Level Return on Investment for CMMI® Process Improvement, Mr. J Perry, BAE Systems
- How Do We Get on the Road to Maturity?, Mrs. Debra Perry, Harris Corporation
- Understanding CMMI Measurement Capabilities Performance & Outcomes: Results from the 2007 SEI State of Measurement Practices Survey, Dr. Dennis Goldenson, SEI
- Using Predicted Delivered Defects as a Management Tool, Mr. Dustin Sims, BAE Systems
- Calibrating the Project Planning Process, Mr. Donald Corpron, Northrop Grumman Corporation
- All Others Bring Data, Ms. Charlene Gross, SEI

TRACK 6

- Executing a Successful CMMI Maturity Level 3 Scampi for Spawar Systems Center Charleston, Mr. Michael Kutch, SPAWAR Systems Center Charleston

- CMMI SCAMPI Appraisals – The People/The Process/The Results-United Space Alliance, LLC Lessons Learned, Ms. Robin Hurst, United Space Alliance, LLC
- Proposed Approach to Heterogeneous CMMI Appraisals, Mr. Joseph Vandeville, Northrop Grumman Corporation
- Selecting a Representative Sample for CMMI Enterprise Appraisals, Ms. Kathryn Kirby, Raytheon Company
- Logistics and Lessons Learned in Conducting an CMMI® Maturity Level 3 Full-Model Scope Enteprise-level Appraisal
  Ms. Kathryn Kirby, Raytheon Company

TRACK 7

- Excellence at the Organization, Team and Individual levels; CMMI, TSP and PSP - Experience, Lessons Learned and Why all Three are Needed, Mr. Girish Seshagiri, Advanced Information Services, Inc.
- IEEE Life Cycle Standards and the CMMI® – Implementation Considerations, Dr. Peter Hantos, The Aerospace Corporation
- Using CMMI and OPM3 to Improve Performance, Mr. Thomas Keuten, Pariveda Solutions
- Complementary or Competing? Achieving Synergy with OPM3®, CMMI®, and ISO 9001-2000, Mr. Mark Scott, Harris Corporation
- Formal Process Definition with Industry Standards, Mr. Chris Armstrong, Armstrong Process Group, Inc.
- Project Management Architecture Design as a Critical Success Factor in CMMI Model Implementation, Mr. Christen MacMillan, L-3 Communications

THURSDAY, NOVEMBER 15, 2007

Lunch and Award Presentation

TRACK 1

- Fast Track to Higher CMMI Maturity Levels: Lessons Learned from Five Initiatives, Ms. Cheryl White, Change Delivery
- Seven Success Factors for CMMI Based Process Improvement, Mr. Orhan Kalayci, XPI - eXtreme Process Improvement
- CMMI Process Improvement: It's Not a Technical Problem, It's a People Problem!, Mr. Rolf Reitzig, Cognence
- Improving Project Proposal Quality via CMMI, Mr. Chen Wang, Institute for Information Industry

TRACK 2

- A Framework to Manage and Evaluate Remote Software Testing Using CMMI, Dr. Aldo Dagnino, ABB, Inc. - US Corporate Research
- CMMI, Configuration Management, and Baseball – How to Score, Ms. Julie Schmarje, Raytheon Company
- Automated Systems for Project Portfolio Management - Project Success and Outstanding Earned Value, Mr. Pothiraj Selvaraj,
  Global Computer Enterprises

TRACK 3

- Project Management by Functional Capability, Mr. Fred Schenker, SEI
- Software Architecture Development Leveraging the Attribute Driven Design and CMMI Methodologies, Dr. Aldo Dagnino,
  ABB, Inc. US Corporate Research
- Systems Assurance – Practices Make Perfect – How Your Engineering and Management Practices Can Help Meet the Assurance Challenge, Mr. Paul Croll, Computer Sciences Corporation
- Tools and Resources to Enable Systems Engineering Improvement, Mr. Michael Kutch, SPAWAR Systems Center Charleston
- Applying CMMI Principles to Certification Process of Legacy Aircraft, Ms. Michele Bruno, The Boeing Company
- Accreditation of Undergraduate Programs in Computing, Software Engineering, Systems Engineering and the Ties to CMMI-based Improvement, Mr. Dan Nash, Raytheon Company
- How Future Trends in Systems and Software Engineering Bode Well for Enabling the Rapid Adoption of CMMI, Dr. Ken Nidiffer, SEI

TRACK 4

- Thought Before Action: A High Maturity Roadmap for the Lower Maturity Organization, Mr. James McHale, SEI
- Integrated Implementation of Advanced Maturity Practices, Mr. Dale Childs, DFAS
- Process Performance Baselines and Models: Duh, I Don't Get It, Ms. Diane Mizukami-Williams, Northrop Grumman Mission Systems
- Expanding Statistical Process Control Across All Engineering Disciplines: A Sequence of Practical Case Studies, Dr. Richard Welch, Northrop Grumman Corporation
- Statistical Process Control Applied to Specification Requirements Process, Mr. Al Florence, The MITRE Corporation
- Implementing High Maturity in a Production Support Environment, Ms. Virginia Slavin, SSCI
- Using the Scientific Method at Levels 4-5, Dr. Jeff Ricketts, Raytheon Company

TRACK 5

- The Productivity Puzzle, Mrs. Jill Brooks, Raytheon Company
- Using Metrics to Develop a Software Project Strategy, Mr. Donald Beckett, Quantitative Software Management
- Lessons Learned in the Implementation of Measurement Techniques for CMMI GP 2.8, Dr. Susanna Schwab, L-3 Communications
- Optimizing the Measurement Process, Mr. Gary Natwick, Harris Corporation
- Measurement Strategies in the CMMI, Dr. Rick Hefner, Northrop Grumman Corporation
- 5 Major Sites, 4 Separate Disciplines, 11,500 Engineers, 1 Data Repository: Having Data You Can Actually Use – Priceless!
  Mrs. Jill Brooks, Raytheon Company

TRACK 6

- Cutting Appraisal Costs in Half, Dr. Rick Hefner, Northrop Grumman Corporation
- Experiences Implementing Very Large High Confidence Enterprise Appraisals, Mr. Paul Byrnes, Integrated System Diagnostics
- Process Compliance the Smart Way, Mr. Gary Natwick, Harris Corporation
- Judging the Suitability of Alternative Practices, Dr. Rick Hefner, Northrop Grumman Corporation
- Lessons Learned Conducting High Maturity SCAMPIs, Mr. Paul Byrnes, Integrated System Diagnostics
- Benefits of SCAMPI Class C in Small Settings, Dr. Mary Anne Herndon, Transdyne Corporation
- Lower Cost, More Effective Alternatives to SCAMPIs, Dr. Rick Hefner, Northrop Grumman Corporation
- Using Workshops to Speed CMMI Adoption and Evidence Gathering, Dr. Rick Hefner, Northrop Grumman Corporation

TRACK 7

- Quality Maturity Model – Foundation for Process Institutionalization, Mr. Sumit Gupta, Royal Bank of Scotland - India Development Center
- Not Just for Software Anymore: Lessons Learned From a CMMI™ Appraisal on Projects in a Nonnuclear Weapons Facility, Mr. Daniel Fritts, Honeywell
- CMMI for Services Overview, Mr. Craig Hollenbach, Northrop Grumman Corporation
- Defining Lean Service and Maintenance Processes that are CMMI Compliant, Mr. Timothy Olson, Lean Solutions Institute, Inc. (QIC)
- Implementing Acquisition and System Engineering Processes in a Maintenance Organization, Mr. Bill Fetech, The MITRE Corporation

7th Annual

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Sponsored by:
National Defense Industrial Association,
Systems Engineering Division
in conjunction with
Software Engineering Institute,
Carnegie Mellon University

NDIA
NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
STRENGTH THROUGH INDUSTRY & TECHNOLOGY

Software Engineering Institute
Carnegie Mellon

Event #8110
November 12-15, 2007
Hyatt Regency Tech Center ◆ Denver, CO

Conference Agenda

SUNDAY, NOVEMBER 11, 2007

3:00 PM - 6:00 PM	Conference Registration Open	Grand Mesa Foyer

MONDAY, NOVEMBER 12, 2007

The Tutorial sessions require a $275 registration fee which is in addition to the Conference registration fee.

7:00 AM - 7:00 PM	Conference Registration Open	Grand Mesa Foyer
7:00 AM - 8:00 AM	Continental Breakfast	Grand Mesa Foyer
8:00 AM - 5:30 PM	Tutorial Sessions (must be registered)	Refer to Following Page
9:45 AM - 10:15 AM	Break (Tutorial Attendees Only)	Grand Mesa Foyer
12:00 PM - 1:00 PM	Lunch (Tutorial Attendees Only)	Grand Mesa ABC Corridor
2:45 PM - 3:15 PM	Break (Tutorial Attendees Only)	Grand Mesa Foyer
5:30 PM - 7:00 PM	Reception (Open to all Attendees)	Atrium Display Area

TUESDAY, NOVEMBER 13, 2007

7:15 AM - 7:00 PM	Conference Registration Open	Grand Mesa Foyer
7:15 AM - 8:15 AM	Continental Breakfast	Grand Mesa Foyer
8:15 AM - 8:30 AM	Welcome & Opening Remarks	Grand Mesa DEF
	◆ *Mr. Sam Campagna, Director, Operations, NDIA*	
	◆ *Mr. Bob Rassa, Director, Systems Support, Raytheon Company*	
8:30 AM - 9:15 AM	State of CMMI®	Grand Mesa DEF
	◆ *Mr. Bob Rassa, Director, Systems Support, Raytheon Company*	
	◆ *Mr. Clyde Chittister, Chief Operating Officer, SEI*	
9:15 AM - 10:00 AM	CMMI® Into the Future	Grand Mesa DEF
	◆ *Mr. Bob Rassa, Director, Systems Support, Raytheon Company*	
10:00 AM - 10:15 AM	Break	Grand Mesa Foyer
10:15 AM - 11:45 AM	Executive Panel	Grand Mesa DEF
	Moderator:	
	Mr. Bob Rassa, Raytheon Company	
	Panelists:	
	Ms. Kristen Baldwin, Office of the Secretary of Defense	
	Mr. Tom Neff, Defense Threat Reduction Agency	
	Mr. Rich Frost, General Motors	
	Mr. Mike Phillips, Software Engineering Institute	
12:00 PM - 1:30 PM	Lunch with Guest Speaker	Grand Mesa ABC Corridor
	◆ *Mr. Mark Schaffer, Director, Systems & Software Engineering, OSD (AT&L)*	
1:30 PM - 5:00 PM	Technical Sessions	Refer to Following Pages
3:00 PM - 3:30 PM	Break	Grand Mesa Foyer
5:00 PM - 6:30 PM	CMMI-ACQ Rollout Reception	Atrium Display Area

WEDNESDAY, NOVEMBER 14, 2007

7:15 AM - 5:00 PM	Conference Registration Open	Grand Mesa Foyer
7:15 AM - 8:15 AM	Continental Breakfast	Grand Mesa Foyer
8:15 AM - 11:45 AM	Technical Sessions	Refer to Following Pages
9:45 AM - 10:15 AM	Break	Grand Mesa Foyer
12:00 PM - 1:30 PM	Lunch with Guest Speaker	Grand Mesa ABC Corridor
	◆ *Ms. Mary Poppendieck, President, Poppendieck, LLC*	
1:30 PM - 5:00 PM	Technical Sessions	Refer to Following Pages
3:00 PM - 3:30 PM	Break	Grand Mesa Foyer

THURSDAY, NOVEMBER 15, 2007

7:15 AM - 5:00 PM	Conference Registration Open	Grand Mesa Foyer
7:15 AM - 8:15 AM	Continental Breakfast	Grand Mesa Foyer
8:15 AM - 11:45 AM	Technical Sessions	Refer to Following Pages
9:45 AM - 10:15 AM	Break	Grand Mesa Foyer
12:00 PM - 1:30 PM	Lunch and Award Presentation	Grand Mesa ABC Corridor
1:30 PM - 5:00 PM	Technical Sessions	Refer to Following Pages
3:00 PM - 3:30 PM	Break	Grand Mesa Foyer

Tutorial Sessions - Monday, November 12, 2007

	Session A	Session A (con't)	Session B	Session B (con't)
	8:00 AM	10:15 AM	1:00 PM	3 :15 PM
Track 1 Grand Mesa D/E	1A1 Tutorial What Do Process Performance Baselines and Models Look Like? ***Dr. Rick Hefner,*** ***Northrop Grumman Corporation***	1A1 Tutorial What Do Process Performance Baselines and Models Look Like? (con't) ***Dr. Rick Hefner,*** ***Northrop Grumman Corporation***	1B1 Tutorial Best-In-Class Early Defect Detection and Defect Prevention ***Mr. Timothy Olson,*** ***Lean Solutions Institute, Inc. (QIC)***	1B1 Tutorial Best-In-Class Early Defect Detection and Defect Prevention (con't) ***Mr. Timothy Olson,*** ***Lean Solutions Institute, Inc. (QIC)***
Track 2 Grand Mesa F	1A2 Tutorial How to Define Practical Systems Engineering Metrics ***Mr. Timothy Olson,*** ***Lean Solutions Institute, Inc. (QIC)***	1A2 Tutorial How to Define Practical Systems Engineering Metrics (con't) ***Mr. Timothy Olson,*** ***Lean Solutions Institute, Inc. (QIC)***	1B2 Tutorial Applying CMMI in Small Settings ***Dr. Rick Hefner,*** ***Northrop Grumman Corporation***	1B2 Tutorial Applying CMMI in Small Settings (con't) ***Mr. Rick Hefner,*** ***Northrop Grumman Corporation***
Track 3 Highlands	1A3 Tutorial Requirements Development and Management ***Mr. Al Florence,*** ***The MITRE Corporation***	1A3 Tutorial Requirements Development and Management (con't) ***Mr. Al Florence,*** ***The MITRE Corporation***	1B3 Tutorial Systems/Software/Hardware Quality Assurance ***Mr. Al Florence,*** ***The MITRE Corporation***	1B3 Tutorial Systems/Software/Hardware Quality Assurance (con't) ***Mr. Al Florence,*** ***The MITRE Corporation***
Track 4 Chasm Creek A	1A4 Tutorial Preparing for and Surviving a SCAMPI Appraisal – A PIID Workshop ***Mr. Raymond Kile,*** ***The Center for Systems Management***	1A4 Tutorial Preparing for and Surviving a SCAMPI Appraisal – A PIID Workshop (con't) ***Mr. Raymond Kile,*** ***The Center for Systems Management***	1B4 Tutorial A Survival Primer for New Process Improvement Explorers ***Dr. Richard Turner,*** ***Systems and Software Consortium***	1B4 Tutorial A Survival Primer for New Process Improvement Explorers (con't) ***Dr. Richard Turner,*** ***Systems and Software Consortium***
Track 5 Mesa Verde	1A5 Tutorial Integrating CMMI, Lean and Six Sigma ***Mr. Robert Ferguson,*** ***SEI***	1A5 Tutorial Integrating CMMI, Lean and Six Sigma (con't) ***Mr. Robert Ferguson,*** ***SEI***	1B5 Tutorial ROI from CMMI and Other Process Improvements ***Mr. Thomas McGibbon,*** ***ITT AES***	1B5 Tutorial ROI from CMMI and Other Process Improvements (con't) ***Mr. Thomas McGibbon,*** ***ITT AES***
Track 6 Wind River	1A6 Tutorial CMMI V1.2 -- An Overview ***Mr. David Phillips,*** ***SEI***	1A6 Tutorial CMMI V1.2 -- An Overview (con't) ***Mr. David Phillips,*** ***SEI***	1B6 Tutorial CMMI Crash Course: What the SEI Won't Teach You (Updated and Improved!) ***Mr. Hillel Glazer,*** ***Entinex, Inc.***	1B6 Tutorial CMMI Crash Course: What the SEI Won't Teach You (Updated and Improved!) (con't) ***Mr. Hillel Glazer,*** ***Entinex, Inc.***
Track 7 Wind Star	1A7 Tutorial Maturity Level 6! Automating Software Engineering Processes with IBM Rational's Suite of Integrated Automation ***Mr. Rolf Reitzig,*** ***Cognence, Inc.***	1A7 Tutorial Maturity Level 6! Automating Software Engineering Processes with IBM Rational's Suite of Integrated Automation (con't) ***Mr. Rolf Reitzig,*** ***Cognence, Inc.***		

BREAK (9:45 AM - 10:15 AM) (TUTORIAL ATTENDEES ONLY)

LUNCH (12:00 PM - 1:00 PM) (TUTORIAL ATTENDEES ONLY)

BREAK (2:45 PM - 3:15 PM) (TUTORIAL ATTENDEES ONLY)

RECEPTION (5:30 PM - 7:00 PM) (ALL ATTENDEES)

Technical Sessions - Tuesday, November 13, 2007

	Session/Chair	Session C 1:30 PM	Session C 2:15 PM	Session/Chair	Session D 3:30 PM	Session D 4:15 PM
Track 1 Grand Mesa D/E	**CMMI and Process Improvement** ***Mr. Brian Gallagher, SEI***	2C1 When the Only Tool You Have is a Hammer, Every Problem Begins to Look Like a Nail ***Mr. Sam Fogle, ACE Guides, LLC***	2C1 The Journey to CMMI Level 3 ***Mr. Andrew Lay, Lockheed Martin Aeronautics Company***	**CMMI and Process Improvement** ***Mr. Brian Gallagher, SEI***	2D1 Visualizing Improvement with Capability Waypoints ***Mr. Robert Jacob, Naval Air Systems Command***	2D1 Institutionalization Measures: Key to Improved Process Monitoring ***Dr. John Rusnak, Lockheed Martin Space Systems Company***
Track 2 Grand Mesa F	**Practical Guidance** ***Dr. Rich Turner, The Stevens Institute***	2C2 How Not to be a CMMI Horror Story: A Simple, Scalable Process Architecture for CMMI that Works for Agile Teams, in Small Settings, and Everywhere Else. Prove Me Wrong. Please!! ***Mr. Hillel Glazer, Entinex, Inc.***	2C2 High Performance versus High Maturity ***Ms. Anita Carleton, SEI***	**Practical Guidance** ***Dr. Rich Turner, The Stevens Institute***	2D2 Jump Starting Multi-Organizational Teams for High Process Capability ***Ms. Joan Weszka, Lockheed Martin Corporate Engineering & Technology***	2D2
Track 3 Highlands	**Lean, Six Sigma Agile and CMMI** ***Ms. Susan Bassham, US Army***	2C3 Assuring Quality for Efficient & Sufficient Testing ***Mr. Pramod Varma, Wipro Technologies***	2C3	**Lean, Six Sigma Agile and CMMI** ***Ms. Susan Bassham, US Army***	2D3	2D3
Track 4 Chasm Creek	**Acquisition** ***Ms. Lorraine Adams, SEI***	2C4 Bridging Process Improvement During Program Management Evolution: An Experience Report ***Capt DeWitt Latimer, USAF***	2C4	**Acquisition** ***Ms. Lorraine Adams, SEI***	2D4	2D4 An "Embedded SCAMPI-C" Appraisal at the National Security Agency ***Mr. Joseph Wickless, SEI***
Track 5 Mesa Verde	**Performance Results** ***Dr. Dennis Godenson, SEI***	2C5 Linking Project Performance to CMMI Process Capability through Lean Measurements ***Mr. Jeffrey Dutton, Jacobs Technology***	2C5	**Performance Results** ***Dr. Dennis Godenson, SEI***	2D5 Quantitative Models for Predicting Project Success ***Dr. Rick Hefner, Northrop Grumman Corporation***	2D5
Track 6 Wind River	**Appraisals** ***Mr. Geoff Draper, Harris Corporation***	2C6 How to Kick Start a Process Improvement Effort to Achieve a CMMI Rating ***Ms. Brenda Hall, Computer Sciences Corporation***	2C6 SEI Appraisal Program Quality Report ***Mr. William Hayes, SEI***	**Appraisals** ***Mr. Geoff Draper, Harris Corporation***	2D6 The Process In-execution Review (PIER) After Three Years ***Mr. Dale Swanson, The MITRE Corporation***	2D6 I'm Preparing My Organization for an Appraisal, but I'm Not Really Sure I Understand this PIID Thing. Should I Worry? ***Mr. Sam Fogle, ACE Guides, LLC***
Track 7 Wind Star	**Multi-Model Implementation** ***Mr. Paul Croll, Computer Sciences Corporation***	2C7 Aligning CMMI and ITIL – Where Am I and Which Way Should I Go ***Mr. Pat Mitryk, Cognence, Inc.***	2C7 Integrated System Framework: A Way Out of the Multi-Model Madness ***Mr. Paul Byrnes, Integrated System Diagnostics***	**Multi-Model Implementation** ***Mr. Paul Croll, Computer Sciences Corporation***	2D7 Combining Multiple Business Lines Under a Single Enterprise Quality Architecture ***Mr. Jeremy Williams, L-3 Communications***	2D7 CMMI Outside the Box: Using Shared Process Architecture to Integrate Control into Process Design ***Mr. Doug Jackson, Robbins-Gioia, LLC***

BREAK (3:00 PM - 3:30 PM)

RECEPTION (5:00 PM - 6:30 PM)

Technical Sessions - Wednesday, November 14, 2007

Track	Session/Chair	Session A 8:15 AM	Session A 9:00 AM		Session/Chair	Session B 10:15 AM	Session B 11:00 AM	
Track 1 Grand Mesa D/E	**CMMI and Process Improvement** ***Mr. Brian Gallagher, SEI***	3A1 CMMI Contenders, CMMI Pretenders ***Dr. Rick Hefner, Northrop Grumman Corporation***	3A1 Initial Fears of CMMI Introduction and How Things Really Played Out ***Dr. Paul Nugent, General Dynamics Advanced Information Systems***	**BREAK (9:45 AM - 10:15 AM)**	**CMMI and Process Improvement** ***Mr. Brian Gallagher, SEI***	3B1 Software Firm + CMMI Level 2 Initiative + 15 months = Dramatic Quality Improvements ***Mr. Jeff Simpson, Campus Management Corporation***	3B1 How to Explain the Value of Every CMMI Practice ***Dr. Rick Hefner, Northrop Grumman Corporation***	**LUNCH (12:00 PM - 1:30 PM)**
Track 2 Grand Mesa F	**Practical Guidance** ***Dr. Rich Turner, The Stevens Institute***	3A2 The What, When, Why and How for CMMI Training ***Mr. Tom Bragg, AVISTA Incorporated***	3A2 Transitioning to the CMMI: What They Never Told You ***Mr. Steve Fried, The Boeing Company***		**Practical Guidance** ***Dr. Rich Turner, The Stevens Institute***	3B2 CMMI Implementation: Overcoming the PPQA Challenge ***Mr. Pat Mitryk, Cognence, Inc.***	3B2 How to Measurably Improve Your Requirements ***Mr. Timothy Olson, Lean Solutions Institute, Inc. (QIC)***	
Track 3 Highlands	**Lean, Six Sigma, Agile, and CMMI** ***Ms. Susan Bassham, US Army***	3A3 Using Lean Six Sigma to Implement CMMI High Maturity Practices ***Ms. Beth Clark, Lockheed Martin***	3A3 The Potential for Lean Acquisition of Software Intensive Systems ***Mr. Jeffrey Dutton, Jacobs Technology***		**Lean, Six Sigma, Agile, and CMMI** ***Ms. Susan Bassham, US Army***	3B3 Lean, CMMI and Six Sigma Working Together to Achieve High Success ***Ms. Susan Bassham, US Army Aviation and Missle Command***	3B3	
Track 4 Chasm Creek	**Acquisition** ***Ms. Lorraine Adams, SEI***	3A4 Driving Process Improvement Using the CMMI-ACQ at General Motors **Dr. Richard Frost, General Motors**	3A4 Leading Indicators for Acquisition Programs ***Mr. Robert Ferguson, SEI***		**High Maturity** ***Dr. Randy Walters, Northrop Grumman Corporation***	3B4 CMMI High Maturity Misconceptions ***Mr. William Hayes, SEI***	3B4 High Maturity: How Do We Know? ***Dr. Mike Konrad, SEI***	
Track 5 Mesa Verde	**Performance Results** ***Dr. Dennis Goldenson, SEI***	3A5 Program Level Return on Investment for CMMI® Process Improvement ***Mr. J Perry, BAE Systems***	3A5		**Performance Results** ***Dr. Dennis Goldenson, SEI***	3B5 How Do We Get on the Road to Maturity? ***Mrs. Debra Perry, Harris Corporation***	3B5 Understanding CMMI Measurement Capabilities Performance & Outcomes: Results from the 2007 SEI State of Measurement Practices Survey ***Dr. Dennis Goldenson, SEI***	
Track 6 Wind River	**Appraisals** ***Mr. Geoff Draper, Harris Corporation***	3A6 Executing a Successful CMMI Maturity Level 3 Scampi for Spawar Systems Center Charleston ***Mr. Michael Kutch, SPAWAR Systems Center Charleston***	3A6		**Appraisals** ***Mr. Geoff Draper, Harris Corporation***	3B6 CMMI SCAMPI Appraisals – The People/The Process/The Results-United Space Alliance, LLC Lessons Learned ***Ms. Robin Hurst, United Space Alliance, LLC***	3B6 Proposed Approach to Heterogeneous CMMI Appraisals ***Mr. Joseph Vandeville, Northrop Grumman Corporation***	
Track 7 Wind Star	**Multi-Model Implementation,** ***Mr. Paul Croll, Computer Sciences Corporation***	3A7 Excellence at the Organization, Team and Individual levels; CMMI, TSP and PSP - Experience, Lessons Learned and Why all Three are Needed **Mr. Girish Seshagiri, Advanced Information Services, Inc.**	3A7 IEEE Life Cycle Standards and the CMMI® – Implementation Considerations ***Dr. Peter Hantos, The Aerospace Corporation***		**Multi-Model Implementation,** ***Mr. Paul Croll, Computer Sciences Corporation***	3B7 Using CMMI and OPM3 to Improve Performance ***Mr. Thomas Keuten, Pariveda Solutions***	3B7 Complementary or Competing? Achieving Synergy with OPM3®, CMMI®, and ISO 9001-2000 ***Mr. Mark Scott, Harris Corporation***	

Technical Sessions - Wednesday, November 14, 2007

	Session/Chair	Session C	Session C		Session/Chair	Session D	Session D	
		1:30 PM	2:15 PM			3:30 PM	4:15 PM	
Track 1 Grand Mesa D/E	**CMMI and Process Improvement** ***Mr. Brian Gallagher, SEI***	3C1 Mrs. Doubtfire Answers Your Questions about Process Improvement ***Dr. Rick Hefner, Northrop Grumman Corporation***	3C1 Developing a Second Generation Directive System Architecture ***Mr. Kenneth Weinberg, Raytheon Company***	BREAK (3:00 PM - 3:30 PM)	**CMMI and Process Improvement,** ***Mr. Brian Gallagher, SEI***	3D1 Whose Processes Are These, Anyway ***Ms. Judith Tejan, AAI Services Corporation***	3D1 Scientific Breakthroughs in Process Improvement **Ms. Cheryl White, Change Delivery Group**	CONFERENCE ADJOURNS FOR THE DAY (5:00 PM)
Track 2 Grand Mesa F	**Practical Guidance** ***Dr. Rich Turner, The Stevens Institute***	3C2 Defining a Decision Analysis and Resolution (DAR) Process Based on Best Practices ***Mr. Timothy Olson, Lean Solutions Institute, Inc. (QIC)***	3C2 Going from Level 3 to Level 5: Lessons Learned ***Mr. Scott Derby, AVISTA Incorporated***		**Practical Guidance** ***Dr. Rich Turner, The Stevens Institute***	3D2 Relationship Between Risk Management and Project Performance ***Mr. Warren Scheinin, Northrop Grumman Corporation***	3D2 Redefining QA's Role in Process Compliance ***Mr. Dean Wooley, Harris Corporation***	
Track 3 Highlands	**Lean, Six Sigma, Agile and CMMI** ***Ms. Susan Bassham, US Army***	3C3 Comparing and Contrasting the PP & PMC Process Areas of CMMI v 1.2 and SCRUM **Dr. Aldo Dagnino** ***ABB, Inc. - US Corporate Research***	3C3 Applying Lean Principles to Systems Engineering **Mr. Timothy Olson, Lean Solutions Institute, Inc. (QIC)**		**Systems Engineering** ***Mr. Jerry Fisher, Aerospace Corporation***	3D3 Effective Systems Engineering: What's the Payoff for Program Performance? ***NDIA Systems EngineeringsEffectiveness***	3D3 What's All this 'churn' in Systems Engineering Standards and Models!? ***Mr. Donald Gantzer, SAIC***	
Track 4 Chasm Creek	**High Maturity** ***Dr. Randy Walters, Northrop Grumman Corporation***	3C4 High Maturity System/Software Cost Estimation ***Dr. Richard Welch, Northrop Grumman Corporation***	3C4 ADVANCE - Implementing a Defect Model for Performance Prediction ***Mr. Stanley Martin, L-3 Communications/IS***		***High Maturity*** ***Dr. Randy Walters, Northrop Grumman Corporation***	3D4 Statistically Managing a Critical Logistics Schedule Using CMMI ***Mr. Robert Tuthill, Northrop Grumman Corporation***	3D4 A More Practical Set of High Maturity Practices ***Dr. Rick Hefner, Northrop Grumman Corporation***	
Track 5 Mesa Verde	**Performance Results** ***Dr. Dennis Goldenson, SEI***	3C5 Using Predicted Delivered Defects as a Management Tool ***Mr. Dustin Sims, BAE Systems***	3C5 Calibrating the Project Planning Process ***Mr. Donald Corpron, Northrop Grumman Corporation***		**Performance Results/ Measurement** ***Dr. Dennis Goldenson, SEI***	3D5 Predicting the Future with CPI ***Mr. Donald Corpron, Northrop Grumman Corporation***	3D5 All Others Bring Data ***Ms. Charlene Gross, SEI***	
Track 6 Wind River	**Appraisals** ***Mr. Geoff Draper, Harris Corporation***	3C6 Selecting a Representative Sample for CMMI Enterprise Appraisals ***Ms. Kathryn Kirby, Raytheon Company***	3C6 Logistics and Lessons Learned in Conducting an CMMI® Maturity Level 3 Full-Model Scope Entreprise-level Appraisal ***Ms. Kathryn Kirby, Raytheon Company***		**Appraisals** ***Mr. Geoff Draper, Harris Corporation***	3D6	3D6	
Track 7 Wind Star	**Multi-Model Implementation** ***Mr. Paul Croll, Computer Sciences Corporation***	3C7 Formal Process Definition with Industry Standards ***Mr. Chris Armstrong, Armstrong Process Group, Inc.***	3C7 Strengthening CMMI Implementation thru PSP Based Bottom-up Approach to Process improvement ***Mr. Ramprasad Tayur Subramahyam, Motorola***		**Non-Development Implementation** ***Mr. Paul Croll, Computer Sciences Corporation***	3D7 Project Management Architecture Design as a Critical Success Factor in CMMI Model Implementation ***Mr. Christen MacMillan, L-3 Communications***	3D7 CMMI—Next Steps ***Ms. Kristen Baldwin, ODUSD (A&T) SSE/SSA***	

Technical Sessions - Thursday, November 15, 2007

Track	Session/Chair	Session A 8:15 AM	Session A 9:00 AM		Session/Chair	Session B 10:15 AM	Session B 11:00 AM	
Track 1 Grand Mesa D/E	**CMMI and Process Improvement** ***Mr. Brian Gallagher, SEI***	4A1 Fast Track to Higher CMMI Maturity Levels: Lessons Learned from Five Initiatives ***Ms. Cheryl White, Change Delivery***	4A1 SE Complexity and Project Management ***Mr. Robert W. Ferguson, SEI***	**BREAK (9:45 AM - 10:15 AM)**	**CMMI and Process Improvement** ***Mr. Brian Gallagher, SEI***	4B1 Seven Success Factors for CMMI Based Process Improvement ***Mr. Orhan Kalayci, XPI - eXtreme Process Improvement***	4B1 CMMI Process Improvement: It's Not a Technical Problem, It's a People Problem! ***Mr. Rolf Reitzig, Cognence, Inc.***	**LUNCH & AWARD PRESENTATION (12:00 PM - 1:30 PM)**
Track 2 Grand Mesa F	**Practical Guidance** ***Dr. Rich Turner, The Stevens Institute***	4A2 Getting Your Arms Around Stakeholder Involvement ***Ms. Susan Byrnes, Natural SPI, Inc.***	4A2 DAR: Appraisal is Coming,… No Trade Studies Anywhere,… Now What? ***Ms. Diane Mizukami-Williams, Northrop Grumman Mission Systems***		**Practical Guidance** ***Dr. Rich Turner, The Stevens Institute***	4B2 Beating the Odds – A Tale of One Company's Rapid Rise to Maturity Level 5 ***Mr. Henry Schneider, Process and Product Quality Consulting, LLC***	4B2 A Framework to Manage and Evaluate Remote Software Testing Using CMMI ***Dr. Aldo Dagnino, ABB, Inc. - US Corporate Research***	
Track 3 Highlands	**Systems Engineering** ***Mr. Jerry Fisher, Aerospace Corporation***	4A3 Project Management by Functional Capability ***Mr. Fred Schenker, SEI***	4A3 Software Architecture Development Leveraging the Attribute Driven Design and CMMI Methodologies ***Dr. Aldo Dagnino, ABB, Inc. US Corporate Research***		**Systems Engineering** ***Mr. Jerry Fisher, Aerospace Corporation***	4B3 Systems Assurance – Practices Make Perfect – How Your Engineering and Management Practices Can Help Meet the Assurance Challenge ***Mr. Paul Croll, Computer Sciences Corporation***	4B3 Tools and Resources to Enable Systems Engineering Improvement ***Mr. Michael Kutch, SPAWAR Systems Center Charleston***	
Track 4 Chasm Creek	**High Maturity** ***Dr. Randy Walters, Northrop Grumman Corporation***	4A4 Thought Before Action: A High Maturity Roadmap for the Lower Maturity Organization ***Mr. James McHale, SEI***	4A4 Integrated Implementation of Advanced Maturity Practices ***Mr. Dale Childs, DFAS***		**High Maturity** ***Mr. Randy Walters, Northrop Grumman Corporation***	4B4 Process Performance Baselines and Models: Duh, I Don't Get It ***Ms. Diane Mizukami-Williams, Northrop Grumman Mission Systems***	4B4 Expanding Statistical Process Control Across All Engineering Disciplines: A Sequence of Practical Case Studies ***Dr. Richard Welch, Northrop Grumman Corporation***	
Track 5 Mesa Verde	**Measurement** ***Dr. Dennis Goldenson, SEI***	4A5 The Productivity Puzzle ***Mrs. Jill Brooks, Raytheon Company***	4A5 Using Metrics to Develop a Software Project Strategy ***Mr. Donald Beckett, Quantitative Software Management***		**Measurement** ***Dr. Dennis Goldenson, SEI***	4B5 Lessons Learned in the Implementation of Measurement Techniques for CMMI GP 2.8 ***Dr. Susanna Schwab, L-3 Communications***	4B5 Optimizing the Measurement Process ***Mr. Gary Natwick, Harris Corporation***	
Track 6 Wind River	**Appraisals** ***Mr. Geoff Draper, Harris Corporation***	4A6 Cutting Appraisal Costs in Half ***Dr. Rick Hefner, Northrop Grumman Corporation***	4A6 Experiences Implementing Very Large High Confidence Enterprise Appraisals ***Mr. Paul Byrnes, Integrated System Diagnostics***		**Appraisals** ***Mr. Geoff Draper, Harris Corporation***	4B6 Process Compliance the Smart Way ***Mr. Gary Natwick, Harris Corporation***	4B6 Judging the Suitability of Alternative Practices ***Dr. Rick Hefner, Northrop Grumman Corporation***	
Track 7 Wind Star	**Non-Development Implementation** ***Mr. Paul Croll, Computer Sciences Corporation***	4A7 Quality Maturity Model – Foundation for Process Institutionalization ***Mr. Sumit Gupta, Royal Bank of Scotland - India Development Center***	4A7 Not Just for Software Anymore: Lessons Learned From a CMMI™ Appraisal on Projects in a Nonnuclear Weapons Facility ***Mr. Daniel Fritts, Honeywell***		**Non-Development Implementation** ***Mr. Paul Croll, Computer Sciences Corporation Mr. Paul Croll,***	4B7 CMMI for Services Overview ***Mr. Craig Hollenbach, Northrop Grumman Corporation***	4B7 Defining Lean Service and Maintenance Processes that are CMMI Compliant ***Mr. Timothy Olson, Lean Solutions Institute, Inc. (QIC)***	

Technical Sessions - Thursday, November 15, 2007

Track	Session/Chair	Session C 1:30 PM	Session C 2:15 PM		Session/Chair	Session D 3:30 PM	Session D 4:15 PM	
Track 1 Grand Mesa D/E	**CMMI and Process Improvement** ***Mr. Brian Gallagher, SEI***	4C1 Untethered Activities - The Real Reason for Schedule Slips ***Mr. Rolf Reitzig, Cognence, Inc.***	4C1 Improving Project Proposal Quality via CMMI ***Mr. Chen Wang, Institute for Information Industry***	**BREAK (3:00 PM - 3:30 PM)**	**CMMI and Process Improvement** ***Mr. Brian Gallagher, SEI***	4D1	4D1	**CONFERENCE ADJOURNS (5:00 PM)**
Track 2 Grand Mesa F	**Practical Guidance** ***Dr. Rich Turner, The Stevens Institute***	4C2 CMMI, Configuration Management, and Baseball – How to Score ***Ms. Julie Schmarje, Raytheon Company***	4C2 Automated Systems for Project Portfolio Management - Project Success and Outstanding Earned Value ***Mr. Pothiraj Selvaraj, Global Computer Enterprises***		**Practical Guidance** ***Dr. Rich Turner, The Stevens Institute***	4D2	4D2	
Track 3 Highlands	**Systems Engineering** ***Mr. Jerry Fisher, Aerospace Corporation***	4C3 Applying CMMI Principles to Certification Process of Legacy Aircraft ***Ms. Michele Bruno, The Boeing Company***	4C3 Accreditation of Undergraduate Programs in Computing, Software Engineering, Systems Engineering and the Ties to CMMI-based Improvement ***Mr. Dan Nash, Raytheon Company***		**Systems Engineering** ***Mr. Jerry Fisher, Aerospace Corporation***	4D3 How Future Trends in Systems and Software Engineering Bode Well for Enabling the Rapid Adoption of CMMI ***Dr. Ken Nidiffer, SEI***	4D3	
Track 4 Chasm Creek	**High Maturity** ***Dr. Randy Walters, Northrop Grumman Corporation***	4C4 Statistical Process Control Applied to Specification Requirements Process ***Mr. Al Florence, The MITRE Corporation***	4C4 Implementing High Maturity in a Production Support Environment ***Ms. Virginia Slavin, SSCI***		**High Maturity** ***Dr. Randy Walters, Northrop Grumman Corporation***	4D4 Using the Scientific Method at Levels 4-5 ***Dr. Jeff Ricketts, Raytheon Company***	4D4	
Track 5 Mesa Verde	**Measurement** ***Dr. Dennis Goldenson, SEI***	4C5	4C5 Measurement Strategies in the CMMI ***Dr. Rick Hefner, Northrop Grumman Corporation***		**Measurement** ***Dr. Dennis Goldenson, SEI***	4D5 5 Major Sites, 4 Separate Disciplines, 11,500 Engineers, 1 Data Repository: Having Data You Can Actually Use – Priceless! ***Mrs. Jill Brooks, Raytheon Company***	4D5	
Track 6 Wind River	**Appraisals** ***Mr. Geoff Draper, Harris Corporation***	4C6 Lessons Learned Conducting High Maturity SCAMPIs ***Mr. Paul Byrnes, Integrated System Diagnostics***	4C6 Benefits of SCAMPI Class C in Small Settings ***Dr. Mary Anne Herndon, Transdyne Corporation***		**Appraisals** ***Mr. Geoff Draper, Harris Corporation***	4D6 Lower Cost, More Effective Alternatives to SCAMPIs **Dr. Rick Hefner,** ***Northrop Grumman Corporation***	4D6 Using Workshops to Speed CMMI Adoption and Evidence Gathering **Dr. Rick Hefner,** ***Northrop Grumman Corporation***	
Track 7 Wind Star	**Extensions** ***Mr. Paul Croll, Computer Sciences Corporation***	4C7 Achieving CMMI Level 3 in a Consulting-based Environment ***Mr. Jeremy Williams, L-3 Communications Enterprise IT Solutions***	4C7 Implementing Acquisition and System Engineering Processes in a Maintenance Organization ***Mr. Bill Fetech, The MITRE Corporation***		**Extensions** ***Mr. Paul Croll, Computer Sciences Corporation***	4D7	4D7	

Systems Engineering Complexity & Project Management

Bob Ferguson, PMP
NDIA: CMMI Technology Conference
November 2007

A conversation

Defining complexity and its effects on projects

Research into tools and methods

Manager: How big is this project?

Developer: I donõt know. This looks really hard.

Manager: Well we need to know how big it is so we can estimate the work.

Developer: Iõll have to figure out how hard it is so I can tell you how long it will take.

These two are talking about different things.

The developer believes that his estimate of size, will not recognize the uncertainty. He wants to know something about the complexity to adjust duration

er’s Concern

The project manager is concerned with staffing and planning to meet the projectôs objectives.

The project manager may not understand what the engineer means by complexity.

- He may interpret the behavior as complaining.
- He may think ñHe always says that, but it doesnôt help his estimate.ò

The project manager does not know what questions to ask, nor has he thought sufficiently about engaging the SE in project planning.

How do we create a new “conversation”?

Questions

What do we mean by the word “complexity”?

What methods can help project managers resolve complexity?

What information can teams provide that shows the resolution of the complexity?

How should the project manager question the staff to identify the complexity?

The project manager and engineer can deal with the complexity problem, provided that each understands and accepts the otherôs concern.

Å The project manager asks the right kind of question.

Å The project manager is amenable to creating a plan that will allow for resolution of the complexity by the engineering staff.

Å The engineer understands how the project plan might help to mitigate the schedule and cost problems that result from complexity.

Å The budget and schedule are not so tightly constrained that the project cannot be accomplished.

The remainder of this talk will describe some planning actions to help resolve select types of project complexity.

A conversation

Defining complexity and its effects on projects

Research into tools and methods

lexity Research

Research considering the complexity in product development projects

- Business Schools
  - Steven Eppinger and Nelson Repenning at MIT
  - Kim Clark at Harvard
- Engineering School papers
  - Ali A. Yassine at Univ. Illinois Urbana-Champagne

Research has considered task structure in response to complex problems in product development ..

lexity

Definitions seem to relate to the difficulty in learning a capability that a team or individual does not currently possess.

- Å ñMcCabe complexityò indicates difficulty in learning to maintain a set of code.
- Å ñTechnology introductionòentails learning a lot of different things: design, testing, technical communications, manufacturing, é
- Å Invention is discovering (learning) a new design pattern

Resolving the complexity depends on some learning process ï

- Å The organization must develop new capabilities.
- Å Some iteration or experiment is required for a satisfactory solution.
- Å The team must learn to work together.

uct Development Complexity

Different learning requirements suggest an approach.

Big

The work has to be divided into teams or sub-projects in order to produce a result soon enough that it has value.

Deep

An unfamiliar design pattern is required. It may even require a new invention.

Conflicting Goals (Design Tradeoff)

Problem requires some form of experimentation, prototyping or other trade-off analysis. An optimal (but not perfect) solution is expected.

Large projects require multiple work groups operating simultaneously and somewhat independently.

Potential Problems

Å Synchronizing the work is very difficult. Teams must sometimes start work on incomplete information.

Å Individuals who fail to fully participate in the work of integrated product teams (IPTs) place additional burdens on the other teams.

Things to be learned:

Å Team boundaries (ñWe do this. You do that. Hereõs how we decide.ö)

Å How to handle incomplete information

Å How to declare completeness

Å How to verify and validate each otherõs work

ement Concerns for “Big”

Needs a picture of team and wbs structure
Relationships show learning

Structuring the teams

- Balance the workload to achieve desired schedule
- Teams have needed skills and resources

Product Concerns

- Sufficiently many integration points to demonstrate learning and product progress (depends on system architecture)

Required activities

- Learning to work together (say 8-24 hours face-to-face time)
- Specific understanding of interfaces and boundaries
- Describing exactly what is incomplete and how the act of completing may affect current results.

…hange on “Big” Projects

Consider that ĩChange Requestsòare an out-of-cycle development request.

Å i.e. some design work is already completed and now has to be re-done.

Considerations

Å Affected work products

Å Affected teams

Å Coordination aspects

Å Ripple effects

...ig Projects

IPT

- Participation and battle rhythm
- Convergence on interfaces
- Issues and rework on interfaces
- Decision bottlenecks
- Design structure matrix to show distance between team members

Architecture

- Design structure matrix to show interdependency
- Structure for integration/verification

An aspect of the design is new to the development team.

Potential problems

- Capability to perform may be missing or have limited capacity for work.
- Productivity suffers and team generates a lot of rework.
- Lack of progress affects other teams and causes synchronization problems.

Things to be learned

- What technology works (algorithm, material, equipment, technique)?
- How and when does it work?
- How do we utilize it in the current product development project?
- Do we want to develop capability and capacity or buy it?

The first use of a genetic algorithm in the application.

- Who must understand the mathematics?
- How long does convergence take?
- How can we test the convergence and result?
- What do we need to document for maintenance?
- What unique bugs could occur in this type application?
- How will this technology affect manufacturing and setup?

ement Concerns for “Deep”

Deep problems take time, but not many people.

- Some very highly skilled individuals will not be available to the larger team for while the deep problem is addressed.
- If these people multi-task, the time required will be much longer.

Required activities

- A deep problem is not ñsolvedò until the **organization** can utilize the technology to produce the final product.
- Technology transfer tools, events and mentoring

Costs and Risk Mitigation require investigating alternative solutions.

- Alternative implementations may be needed in the interim, but may not fully meet quality attribute objectives.
- Buy required technology and/or development capacity (risk transfer)

...oals" (CG)

Some stakeholder values are in apparent conflict.

- More power and less fuel consumption
- Faster performance and more security
- Flexibility to install devices and information assurance
- Faster product delivery and more robust design

Conflict may be between stakeholders increasing the difficulty

- Theory of Constraints work may help with conflict resolution

als Problems and Learning

Potential problems

- Separate teams may attempt to achieve the goals independently. Each team then changes the resulting system behavior in some way opposite the other's goal.
- Slow decision process
- Usually requires multiple iterations for resolution.
- Conflict not exposed soon enough for appropriate resolution.

Things to be learned

- What are the important interactions? What values work?
- What are the sensitivity points and trade-offs inherent in our design (architecture)?
- How can we see that our required iterations are converging?

ement of Conflicting Goals

These problems always require some form of experimentation.

- Experiments include simulation, scenario analysis, trade studies and prototype products
- There is a cost to experimentation that can be hard to plan.

Required Activities

- Identify sensitivity points and trade-offs.
- Check modularity against team structure so that decision involves as few teams as possible.
- Plan some number of iterations before capability is required.
- Create extra integration points to show that complexity was actually resolved.
- Consider transforming problem into a ñdeepòproblem. (Find a technological approach).

A conversation

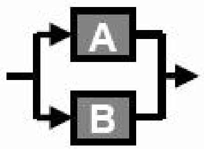
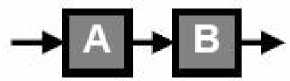
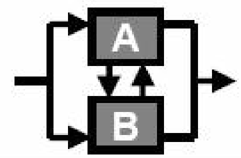
Defining complexity and its effects on projects

Research into tools and methods

hods

Design Structure Matrix (DSM)

- DSM has proved to be a fairly successful approach to partitioning and analyzing very large systems. (picture)

<table>
<tr><th colspan="4">Three Configurations that Characterize a System</th></tr>
<tr><td>Relationship</td><td>Parallel</td><td>Sequential</td><td>Coupled</td></tr>
<tr><td>Graph Representation</td><td></td><td></td><td></td></tr>
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<td><table><tr><td></td><td>A</td><td>B</td></tr><tr><td>A</td><td></td><td></td></tr><tr><td>B</td><td></td><td></td></tr></table></td>
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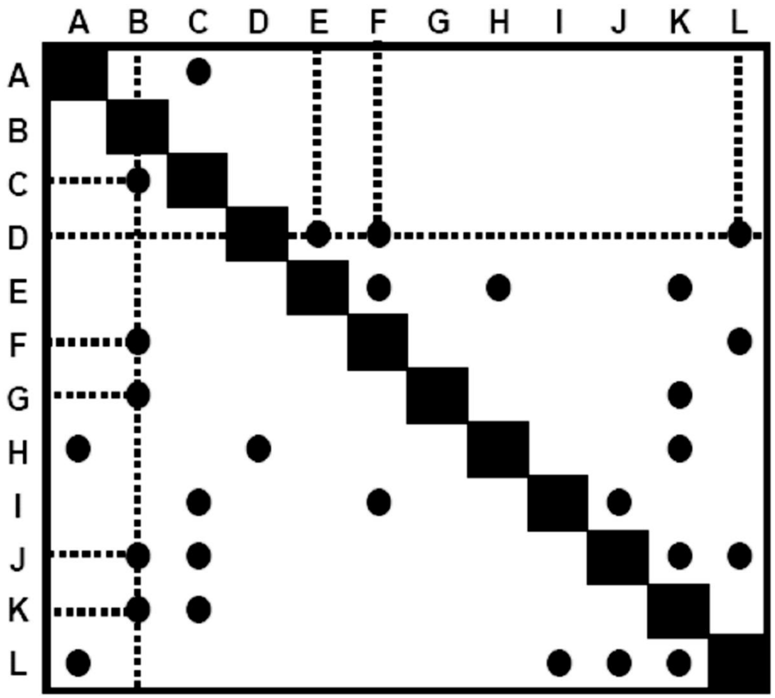
d Methods

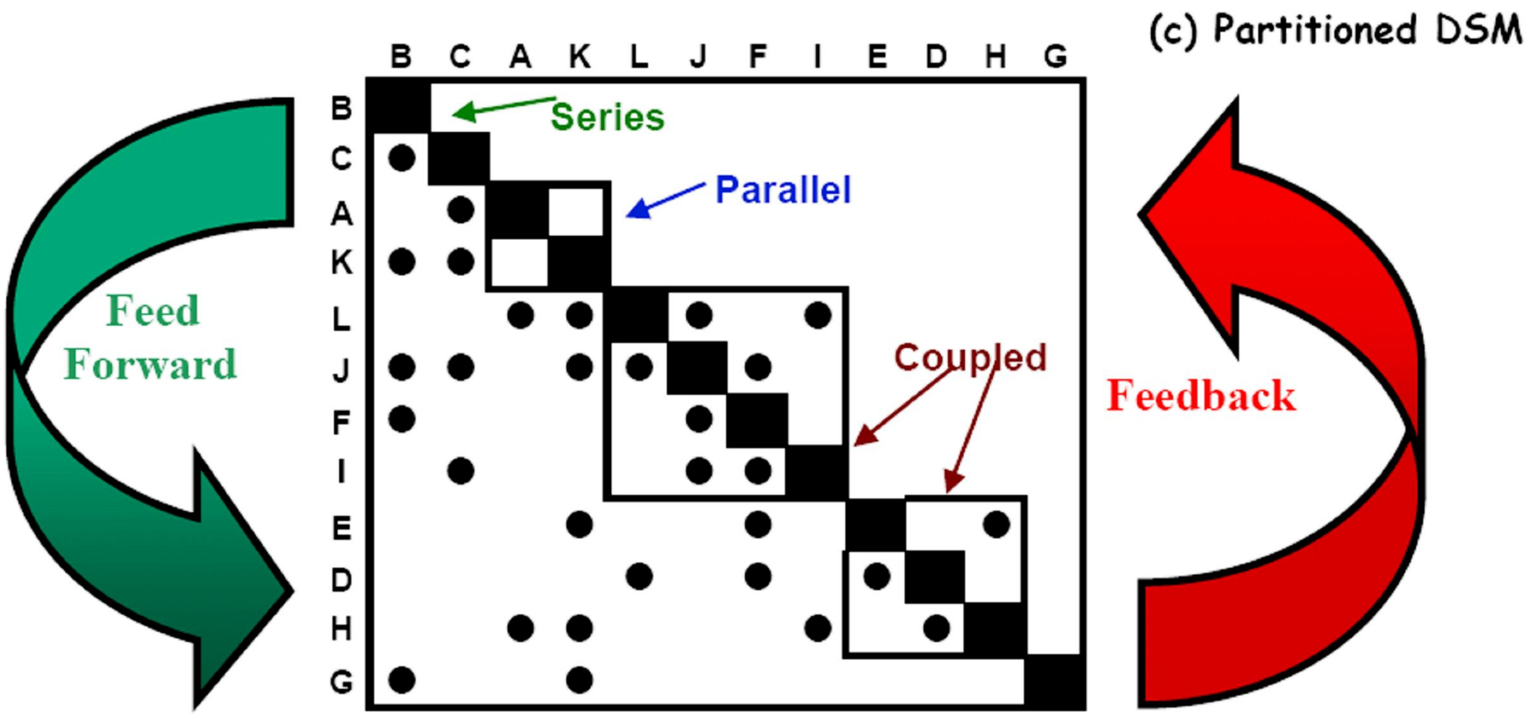
DSM Data Types	Representation	Application	Analysis Method
Task-based	Task/Activity input/output relationships	Project scheduling, activity sequencing, cycle time reduction	Partitioning, Tearing, Banding, Simulation and Eigenvalue Analysis
Parameter-based	Parameter decision points and necessary precedents	Low level activity sequencing and process construction	Partitioning, Tearing, Banding, Simulation and Eigenvalue Analysis
Team-based	Multi-team interface characteristics	Organizational design, interface management, team integration	Clustering
Component-based	Multi-component relationships	System architecting, engineering and design	Clustering



This matrix represents one with a lot of complexity.

Modularity and team arrangement is not clear.

By re-ordering the matrix we can achieve a better team structure and better modularity of both task and design.


(c) Partitioned DSM
B C A K L J F I E D H G
B C A K L J F I E D H G
Series
Parallel
Coupled
Feed Forward
Feedback

ng Strategies

Scheduling

Å DSM provides useful information about

ð Team interdependencies ï requires exchange of incomplete knowledge and active participation

ð Component interaction ï Requires documentation and tests

ð Iteration ï requires planned extra steps

Team Learning

Å Joint scenario work

Å Simulations of work flow

Å Joint inspections

Å Facilitators for planning

s for Deep and CG Problems

Best known method **TRIZ** (treez)

- Addresses both ñDeepò and ñConflicting Goalsò
- Consists of 40 strategies for innovation and problem solving.
- Applies mostly to hardware engineering
  - Such as physical separation of function
  - Time-dependent separation of function

QFD relates design goals to design with cost elements and exposes conflicting goals

QAW, **ATAM** expose many conflicting goals problems

Design Structure Matrix

- Has potential for mathematical approaches such as ñwork-eigenvectorò and simulation of task structure.

g for Deep

Dedicated, highly skilled resources

Knowledge transfer, process implementation

- Å The new technology has to be adapted to the rest of the product development team. It may require additional resources.

Validation of utility of results (testing, learning, etc.)

- Å New capability will include design patterns, test patterns, documentation skills, customer support skills, etc.

Highly skilled resources are not always good at technology transfer. Senior engineering management, developers and testers all need to learn something from a deep problem. Some participation in progress reviews and experiments needs the support of these other people.

n Methods for Deep Problems

Alternative method

- Parallel teams attempt different solutions
- Purchase products or the development capacity from outside

Experiments

- Trade studies, prototypes, simulation

Project management consideration

- Resolution of deep problems has to start as early as possible or the schedule will grow while capability and capacity problems are resolved.
- All methods associated with deep problems have the possibility of taking a very long time to resolve.
- It is essential to have a reasonable method at the time of integration even if the solution is not optimal.

Complexity Type

Partitioning of ñBigòcan aggravate ñConflicting-Goals.ò

Å Separation of concerns approach may allow engineers to view their responsibility for <quality-attribute-A> as independent from <quality-attribute-B> resulting in a sub-optimal design.

Sometimes work on ñDeepòproblems results in ñBigòor ñConflicting-Goalsòproblems.

Å As when the primary solution to the Deep problem is to partition it into several other problems.

Some ñConflicting-Goalsòproblems can be addressed algorithmically resulting in a ñDeepòproblem.

ship

IPPD goals address the Big problem and Conflicting Goals problem

- IPT structure is key
- Must monitor IPT learning and non-learning (issues, etc.)
- IPT must discuss content as well as schedule if members are to learn.
- Integrated Product concept has to be at the forefront of the project manager's attention as the primary near-term goal for each IPT.

Technical Solution

- Does not satisfactorily address Deep problems
- We must include specific efforts to develop the competencies and capabilities of staff and process to introduce a technical innovation.
- Even choosing an outside supplier for the solution requires development of new internal capabilities.

entation

Maturity Level	Process Areas
Optimizing	Causal Analysis and Resolution Organizational Innovation and Deployment
Quantitatively Managed	Quantitative Project Management Organizational Process Performance
Defined	Organizational Process Focus **Organizational Process Definition** Organizational Training **Integrated Project Management** Risk Management **Acquisition Technical Management** **Acquisition Verification** **Acquisition Validation** Decision Analysis and Resolution
Managed	**Acquisition Requirements Development** **Agreement Management** Project Planning Project Monitoring and Control Requirements Management Configuration Management Process and Product Quality Assurance Measurement and Analysis **Solicitation and Supplier Agreement Development**

We can teach project managers and systems engineers (architects) to talk with each other about complex problems.

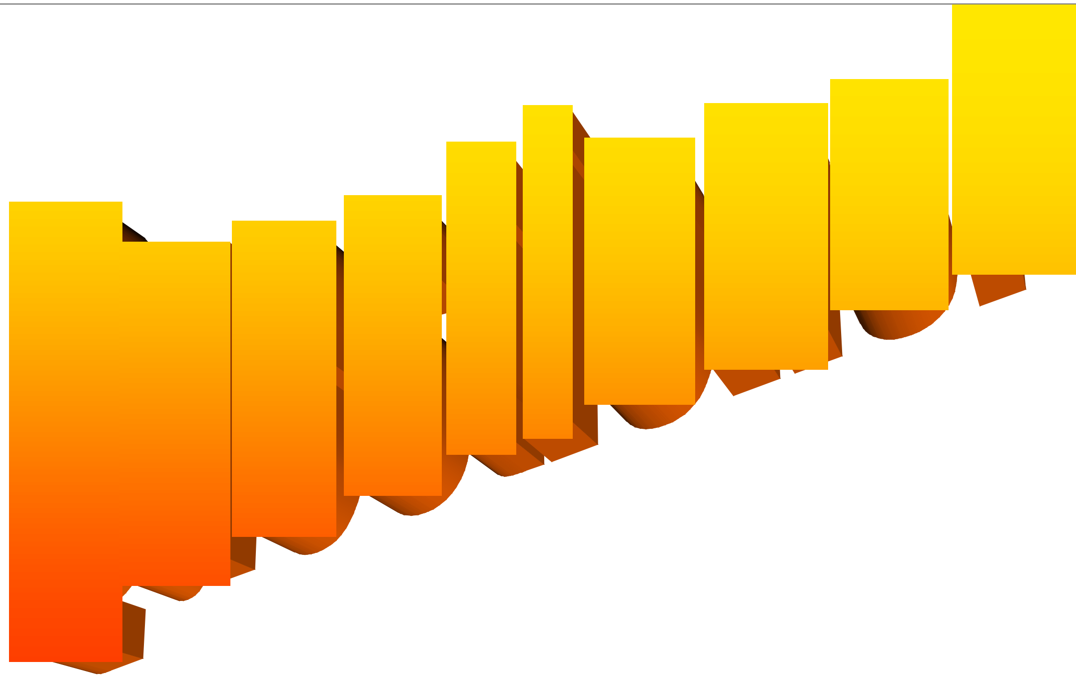
This talk described complexity as 3 different type problems.

- Big, Deep, Conflicting Goals

Addressing each type of complexity calls for different project management strategies.

Each strategy must address the technical problem, product integration, learning events and the project social network.

- We need to identify ways to monitor that the development team is actually learning as a means of checking progress.



Bob Ferguson, PMP

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eXtreme Process Improvement

Seven Success Factors for CMMI based Process Improvement

Orhan KALAYCI
orhan.kalayci@xpi.ca
November 2007

http://www.xpi.ca

eXtreme Process Improvement

Risk of Failure

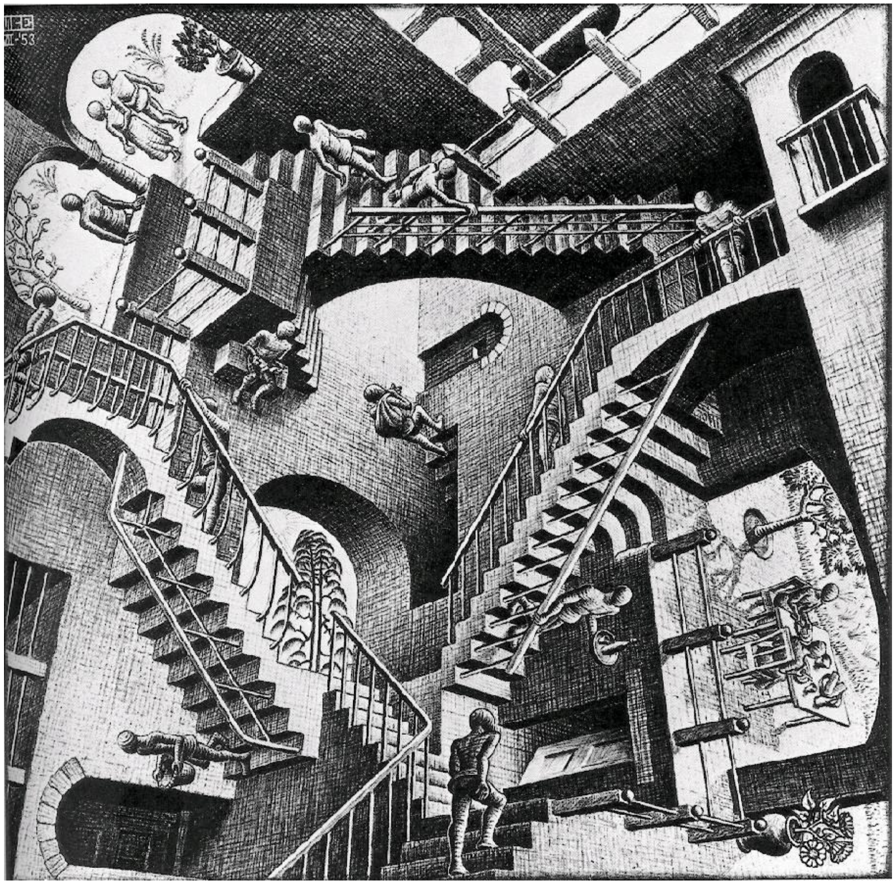
STRATEGIC PLANNING ASSUMPTION(S)

Two-thirds of process improvement initiatives within application development organizations will fail within three years of initiation (0.7 probability).

Matthew Hotle, ***Why Process Improvement Efforts Fail***, Gartner, Publication Date: 9 April 2002, ID Number: TG-15-4929

eXtreme Process Improvement

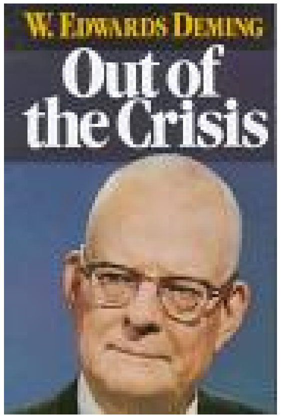
Definition of Success



eXtreme Process Improvement

Definition of Success

1950 - Deming



Input → Process → Output

-5% Investment

-20% defective

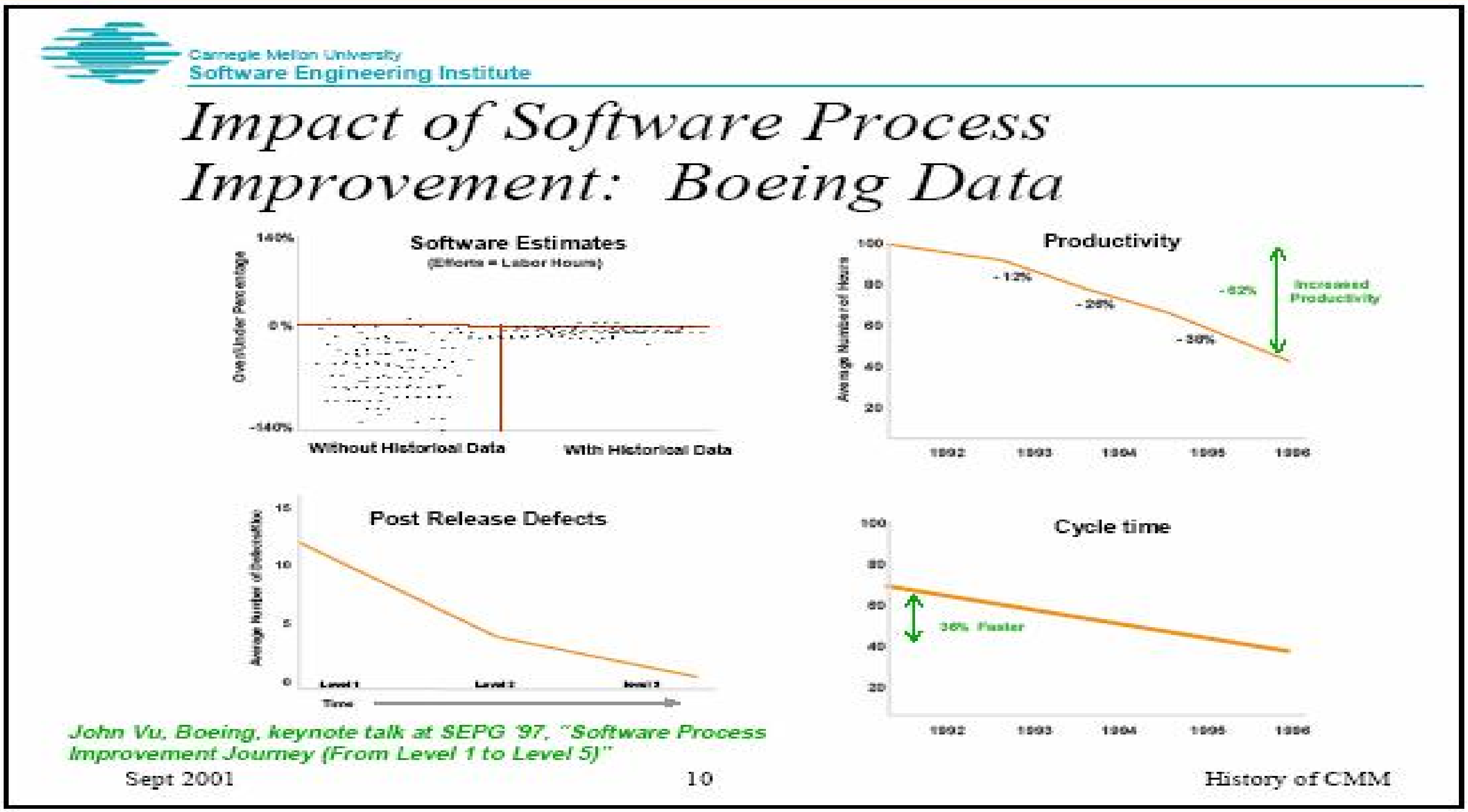
-10% defective

+10% savings

Less Defect (High Quality) with less unit cost

eXtreme Process Improvement

Definition of Success



eXtreme Process Improvement

Risk of Failure

STRATEGIC PLANNING ASSUMPTION(S)

Two-thirds of process improvement initiatives within application development organizations will fail within three years of initiation (0.7 probability).

Matthew Hotle, ***Why Process Improvement Efforts Fail***, Gartner, Publication Date: 9 April 2002, ID Number: TG-15-4929

eXtreme Process Improvement

Seven Success Factors

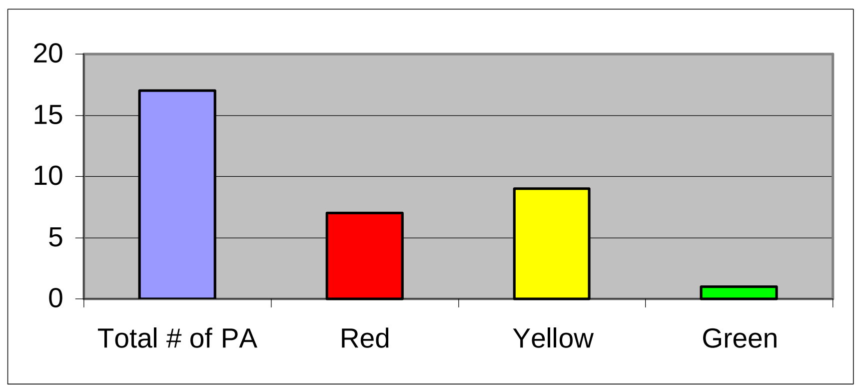
- Business Objectives & Leadership
- Separation of Powers & Ceasing Over-Commitment
- Result-Oriented Processes
- Wide Spread Involvement & Awarding System
- Correct Planning for Transformation
- Tools are Just Tools!
- Sustainable Transformation

eXtreme Process Improvement

Meteksan - April 2006

#	PA	Status	# of weaknesses	EUAS	ABYS	CSGB	ARIP
1	REQM	Y	2				
2	PP	Y	5				
3	PMC	R	10				
4	MA	R	4				
5	CM	Y	2				
6	PPQA	Y	1				
7	RD	Y	2				
8	TS	R	No Obs				
9	VER	Y	No Obs				
10	VAL	R	No Obs				
11	PI	R	No Obs				
12	RSKM	Y	4				
13	IPM	R	6				
14	OPF	Y	1				
15	OPD	Y	2				
16	DAR	R	No Obs				
17	OT	G	0				

Summary	
Total # of PA	17
Red	7
Yellow	9
Green	1



Green	Yellow	Red
0	1	0
0	1	0
0	0	1
0	0	1
0	1	0
0	1	0
0	1	0
0	0	1
0	1	0
0	0	1
0	0	1
0	1	0
0	0	1
0	1	0
0	1	0
0	0	1
1	0	0
1	**9**	**7**

eXtreme Process Improvement

Meteksan - July 2006

Typical Issues in CMMI Implementations		Status	Çözüm Onerileri
1	Business Objectives linked to CMMI		
2	Tools (too much expactions from tools)		
3	Plan (long term short term balance)		Aylėk Gözden Geçirme Toplantėlar
4	Seperations of Powers (Implementation, Consulting, Appriasal)		Süreç Sorumluluklarėnėn Prj ve Grup Yöneticilerine daį ėtėlmasė
5	Organization (no democracy during war) / Overcommitment		- %20 fazla kestirimler - Geçikmelere sempatik yaklaķėyoruz - CMMI Fazla zaman alėyor demek yanlėķ (baķka bir ifade bulmak) - Proje Ynt. İķ yükü
6	Human Factor (no slaves but believers)		- **"Amacı ve faydası" anlamadığınız herşeyi lütfen sorun** - A4 Süreçler - Süreç Haritasė Posteri - CEP CMMI - CMMI Süreç Alanlarėnėn üzerinden geçmek
7	Leadership (from top to down) -- Group Mng, Prj Mng.		Ayda 2 kere toplantė- Grup Ynt, Prj Ynt, Süreç Sahipleri, Bireyler

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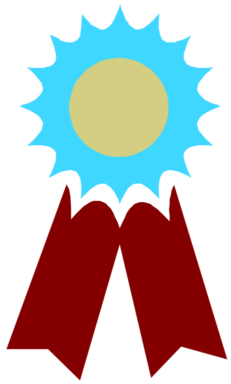
Meteksan - December 2006



Meteksan Sistem
Kurumsal Uygulamalar ve
Yazılım Geliştirme Direktörlüğü

CMMI ML3

eXtreme Process Improvement

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Business Objectives & Leadership

Typical Business Objectives:

1. Increase Scope
2. Decrease Cost
3. Decrease Duration
4. Decrease Defects

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Business Objectives & Leadership

How many leaders?
Who is leader?

Business Objectives & Leadership

The Broken Windows Theory

Å Identify the broken windows
Å Fix them
Å Warn the one who broke it, punish if necessary

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Business Objectives & Leadership

Three Secrets of Japan Emperor

eXtreme Process Improvement

Business Objectives & Leadership

Three Secrets of Japan Emperor

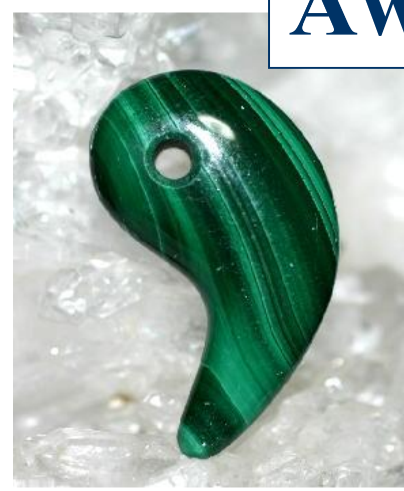
eXtreme Process Improvement

Business Objectives & Leadership

Three Secrets of Japan Emperor

Objective Info

Award



Penalty

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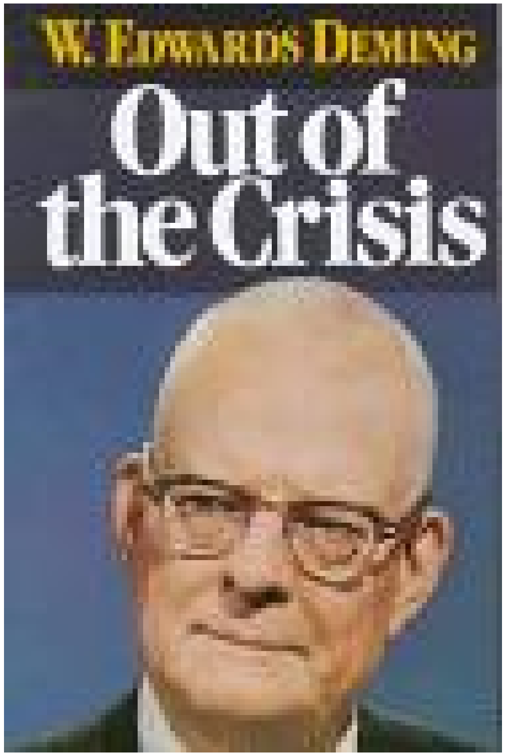
Business Objectives & Leadership

Deming's 14 points

1."Create constancy of purpose towards improvement".
2."Adopt the new philosophy".
3."Cease dependence on inspection".
4."Move towards a single supplier for any one item."
5."Improve constantly and forever".
6."Institute training on the job".
7."Institute leadership".
8."Drive out fear".
9."Break down barriers between departments"
10."Eliminate slogans"
11."Eliminate management by objectives".
12."Remove barriers to pride of workmanship".
13."Institute education and self-improvement".
14."The transformation is everyone's job".



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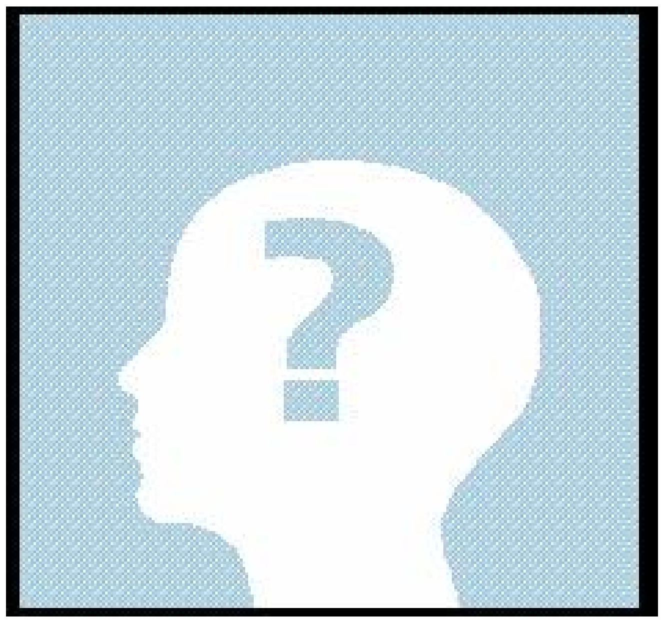
Business Objectives & Leadership

WHY?



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e X treme P rocess I mprovement

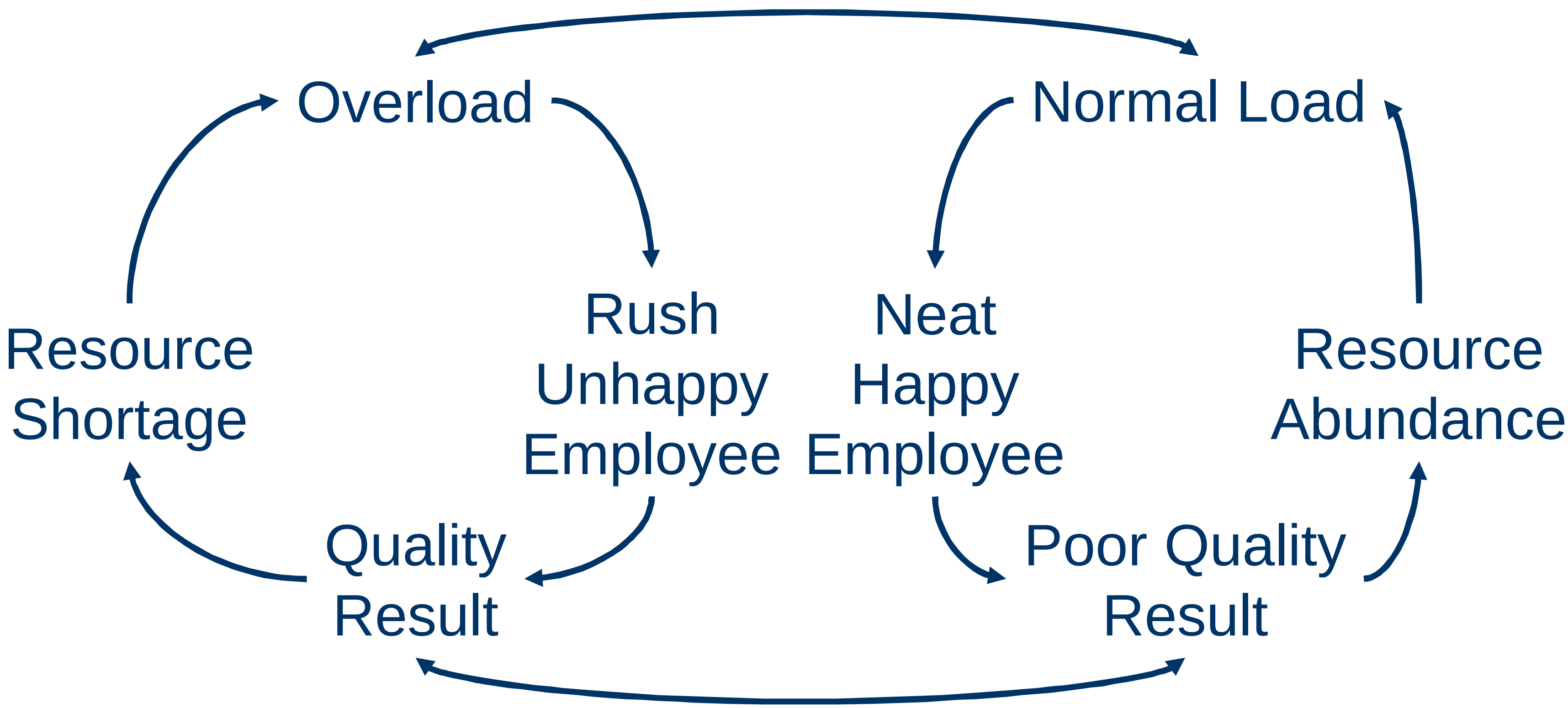
Separation of Powers & Ceasing Over-Commitment

eXtreme Process Improvement

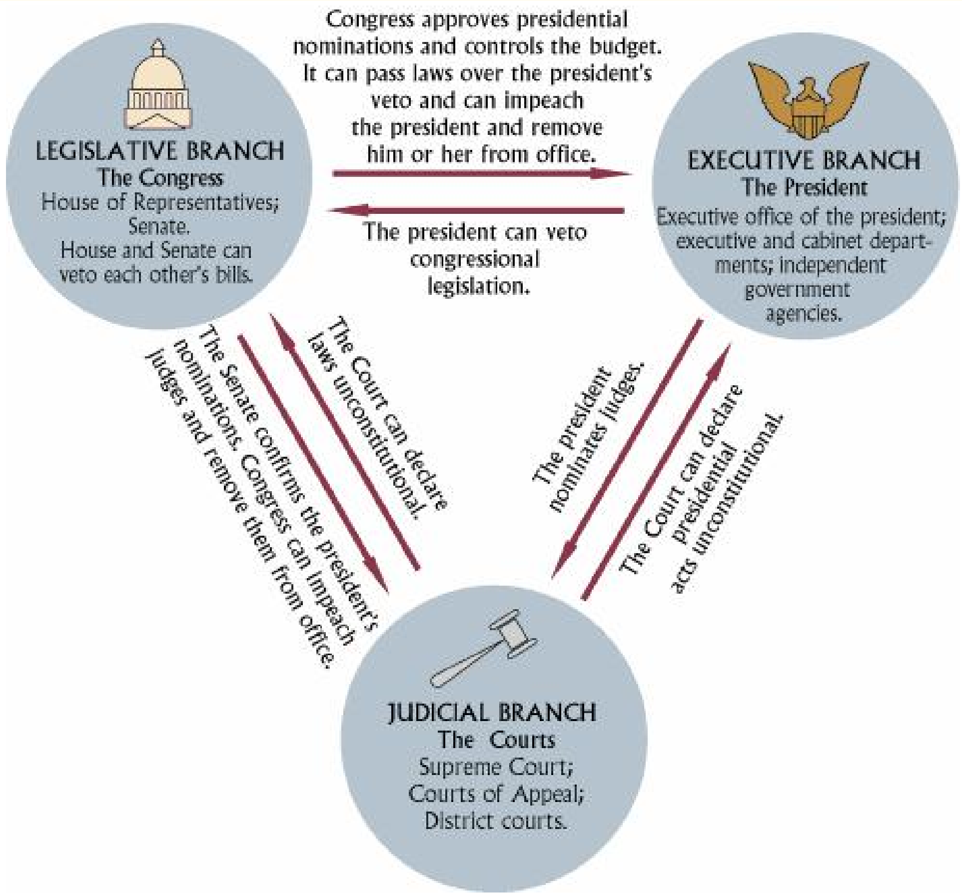
Separation of Powers & Ceasing Over-Commitment

eXtreme Process Improvement

Separation of Powers & Ceasing Over-Commitment



Separation of Powers & Ceasing Over-Commitment



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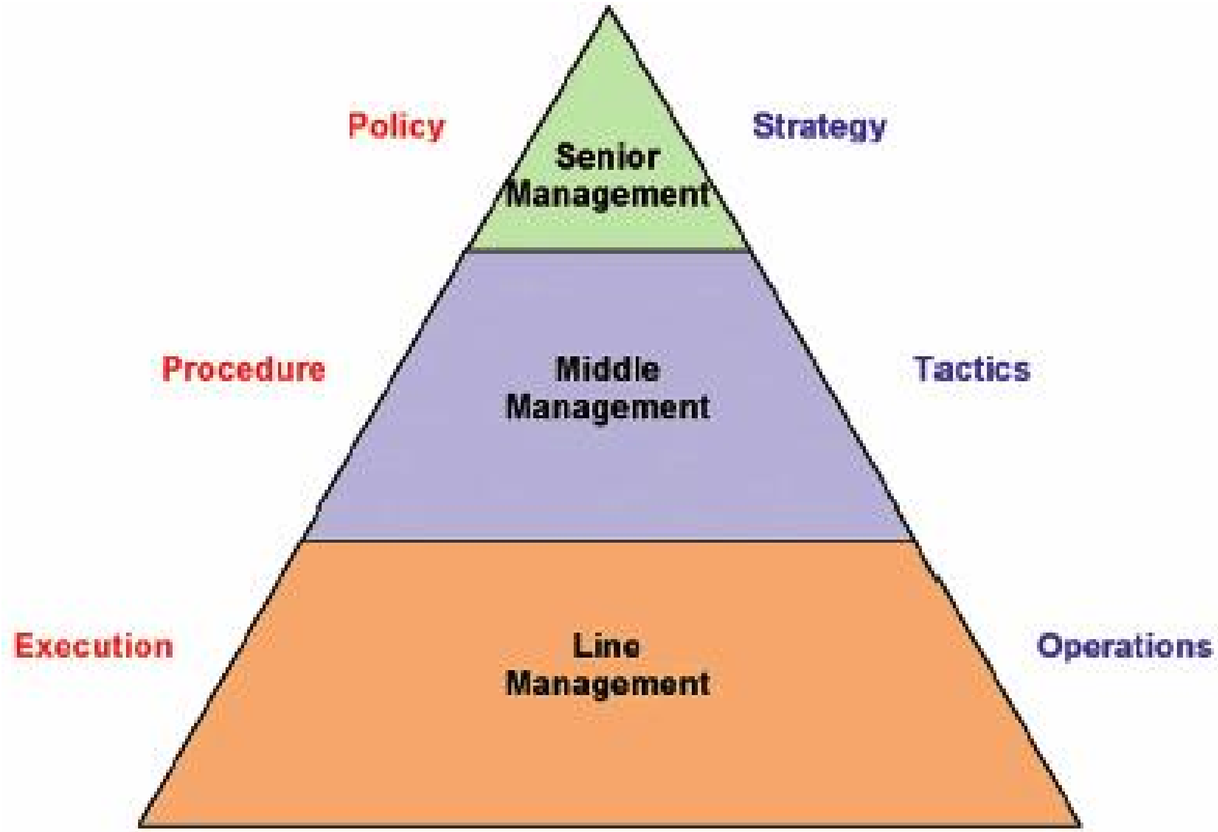
Separation of Powers & Ceasing Over-Commitment



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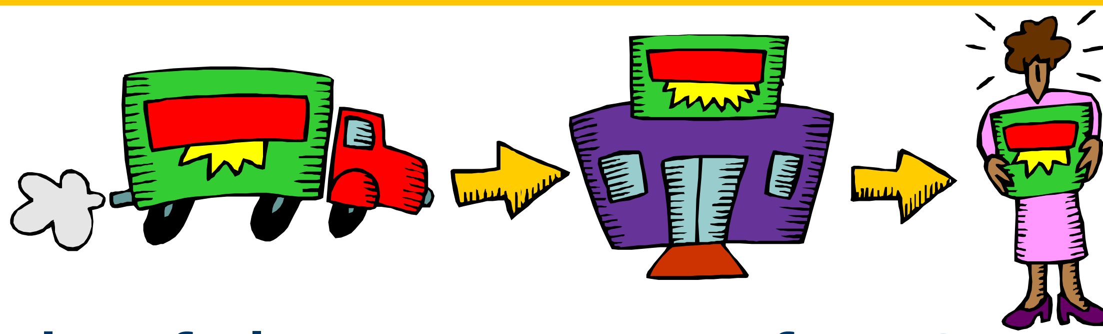
Result-Oriented Processes



Meaningful Processes for Customer

A Large Financial Software Company

1. Provide good products at good prices
2. Acquire customers and maintain good relations with them
3. Make it easy to buy from us
4. Provide excellent services and support after the sale

Texas Instrument

1. Strategy Development
2. Product Development
3. Customer design and support
4. Manufacturing capability development
5. Customer communication
6. Order fulfilment

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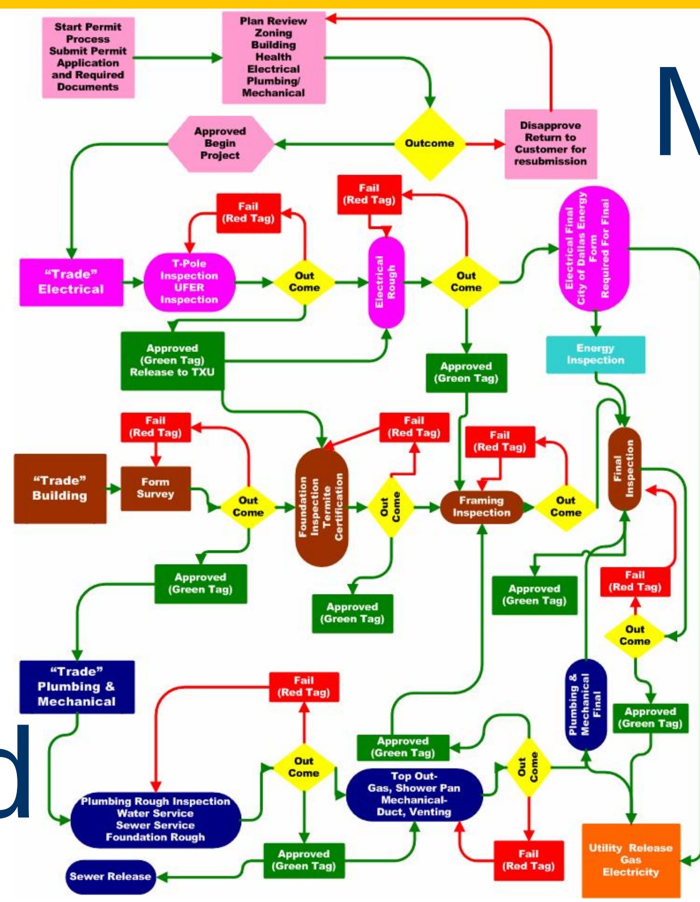
Result-Oriented Processes

Simple

Meaningful



Result Oriented

Multi Layered

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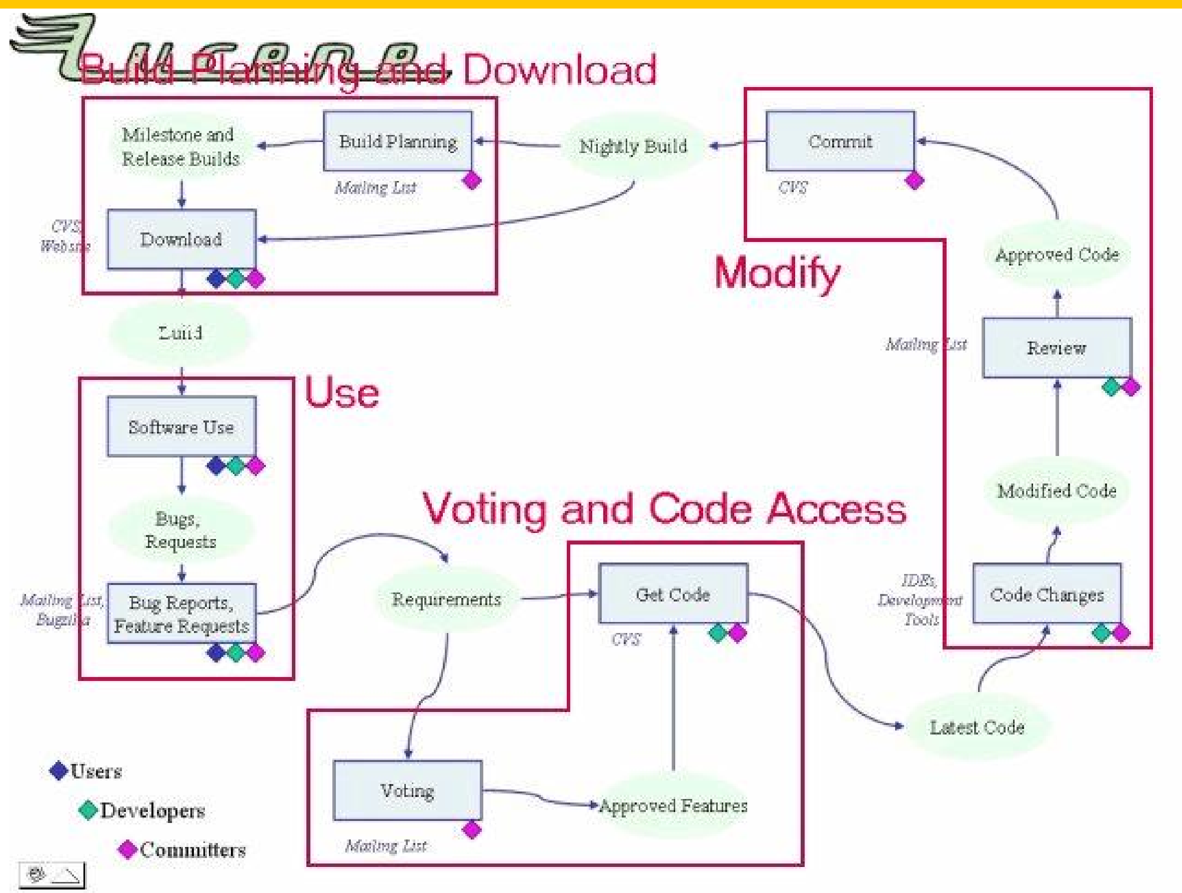
Result-Oriented Processes



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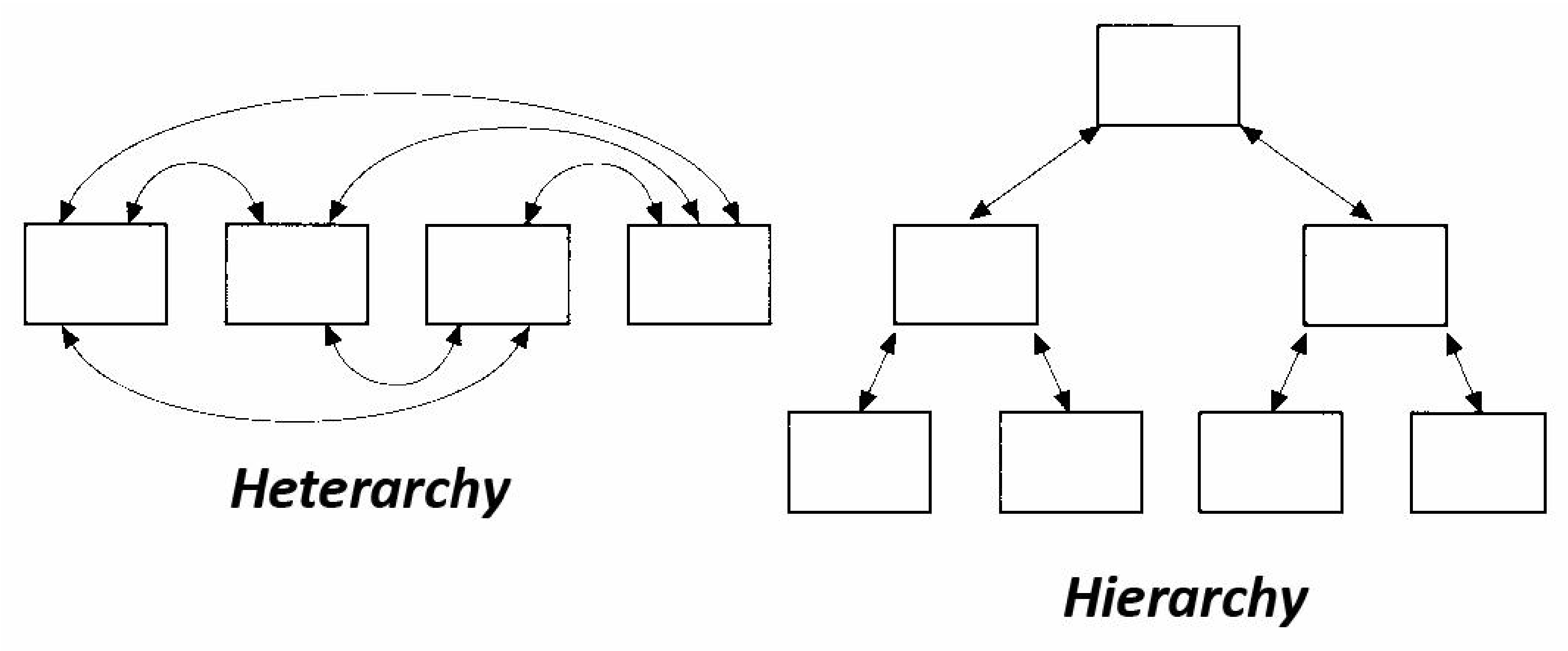
Result-Oriented Processes



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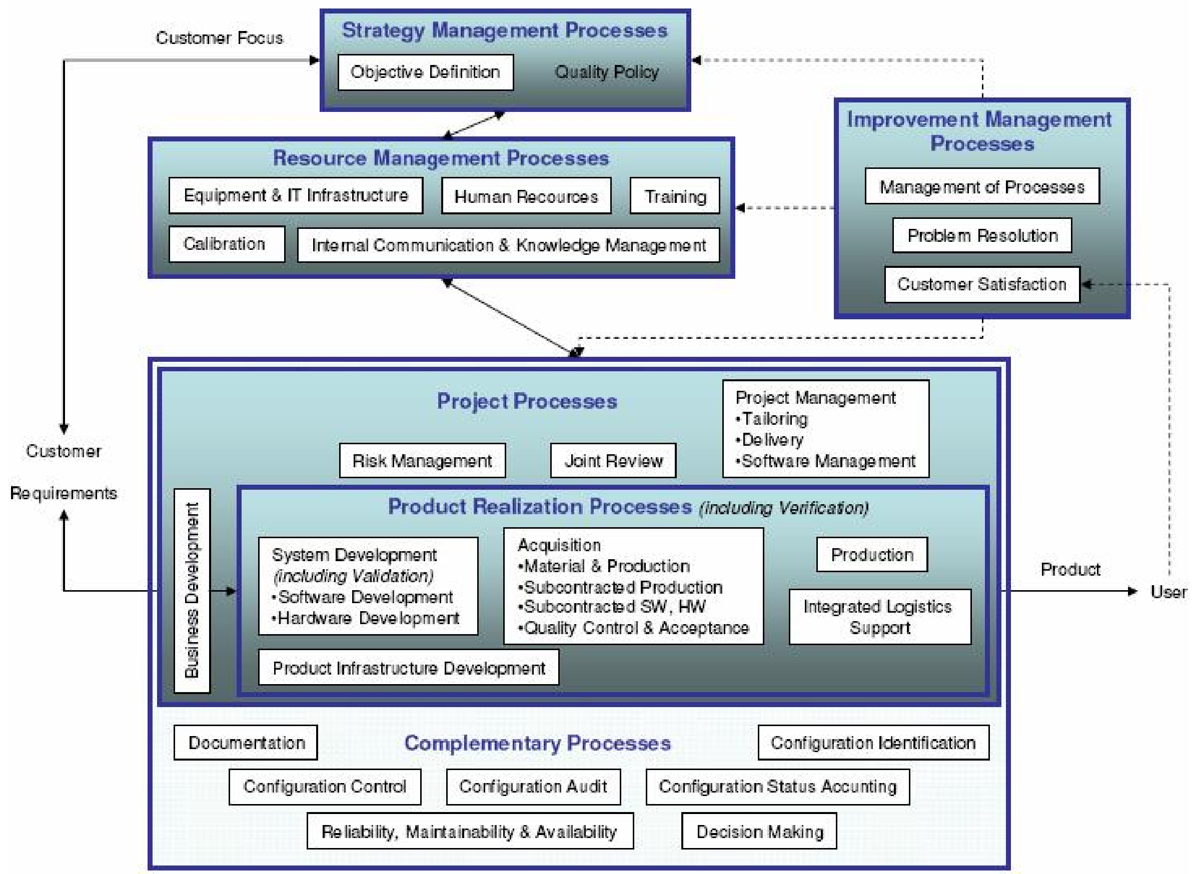
Result-Oriented Processes



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eXtreme Process Improvement

Wide Spread Involvement & Awarding System

eXtreme Process Improvement

Wide Spread Involvement & Awarding System

#	PA	Processes		Process Owner	PM	Developer	CM	SQA	Test
1	PP, PMC, IPM	Proje Yönetim	P	Kadriye	Hakan	ķafak			Emre
2	RSKM	Risk Yönetimi	P	Filiz	Pelin	Güçlü			Günek
3	REQM, RD	Gereksinim Müh.	P	Ulak	Hakan	Ķem Emre Bayram			
4	TS	Teknik Çözüm	P	Ziya	Mustafa Kemal	Emre Ergüden			
5	PI	Ürün Entagrasyonu	P	Murat Orun	Yalçēn	Mesut			
6	VER	Gözden Geçirme	P	Elçin	Ersan	Ķkay			
7	VER, VAL	Yazđēm Testi	P	Yekim	Ziya	Dilan	Ulak	Canan	Yekim
8	PPQA	Yazđēm Kalite Güvence	P	Canan	Tüfekçi	Yeliz			
9	CM	Yazđēm Konf. Ynt.	P	Sevtaç	MMT	Ufuk			
10	DAR	Karar Analizi ve Çözüm	P	ķahin	Muhammed	Onur ķentürk			
11	MA	Ölçme ve Analiz	O	Koray	Hüseyin Erdem	Elif			
12	OPD, OPF	Süreç Yönetimi	O	Eda	Filiz	Dilek			
13	OT	Kurumsal Eĵ itim	O	Banu	Melike	Aykegül			
14	OPF	Yazđēm Yönetiminin Gözden Geçirilmesi	O	Umut	Ali Çakēcē	Yēlmaz			
15		Ķk Geliktirme	O	Gökmen	Kadriye	Dilek			Yekim
16	CM	Deĵ ikiklik Yönetimi	P	Sibel	Asēm	Gülnur			

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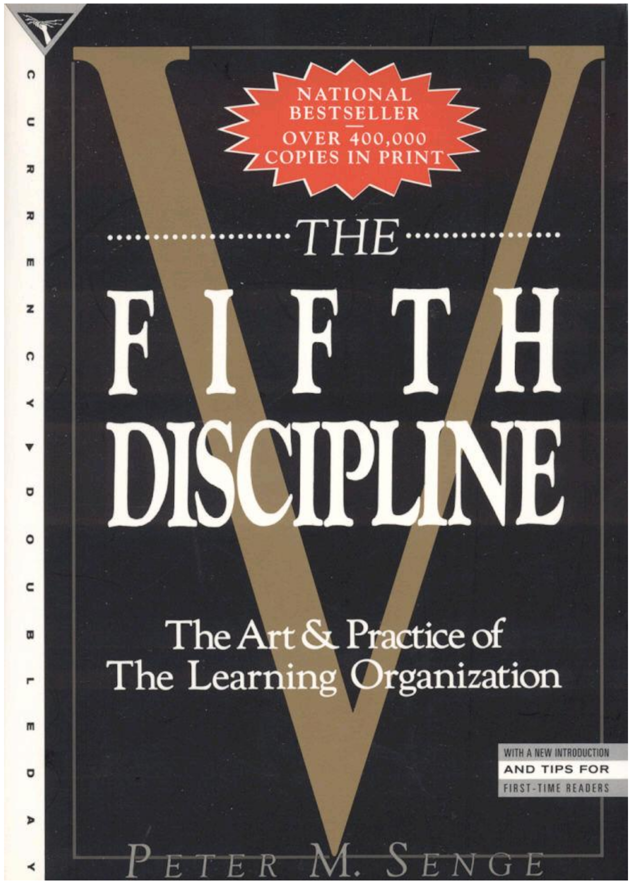
Wide Spread Involvement & Awarding System

The Fifth Discipline

1. Personal Mastery
2. Shared Vision
3. Mental Models
4. Team Learning
5. Systems Thinking



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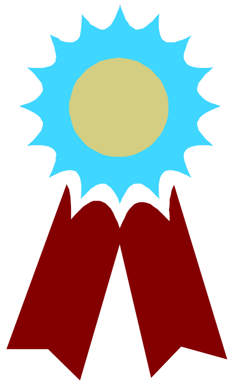
Wide Spread Involvement & Awarding System



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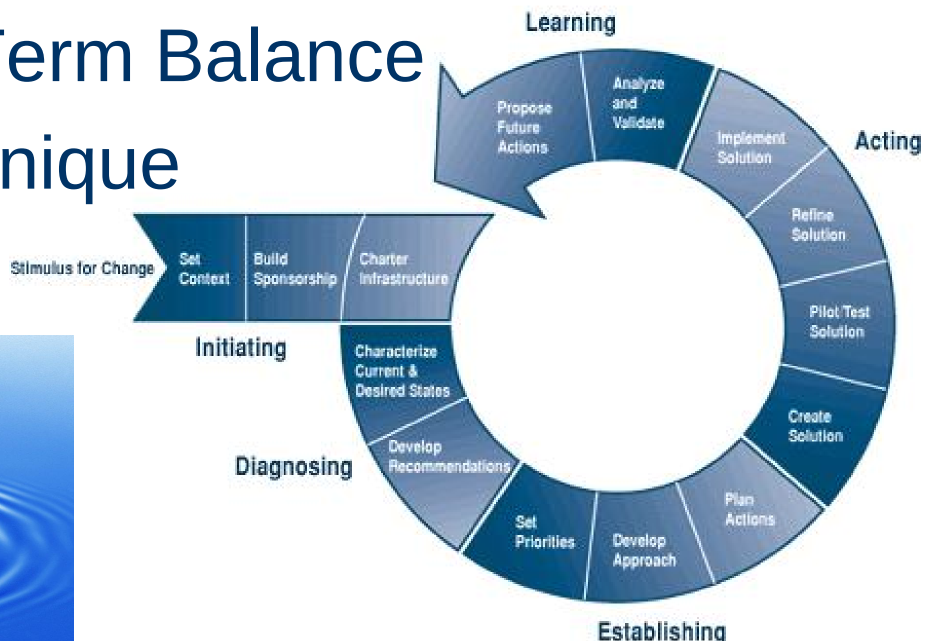
Correct Planning for Transformation

- IDEAL
- Short and Long Term Balance
- Water Drop Technique



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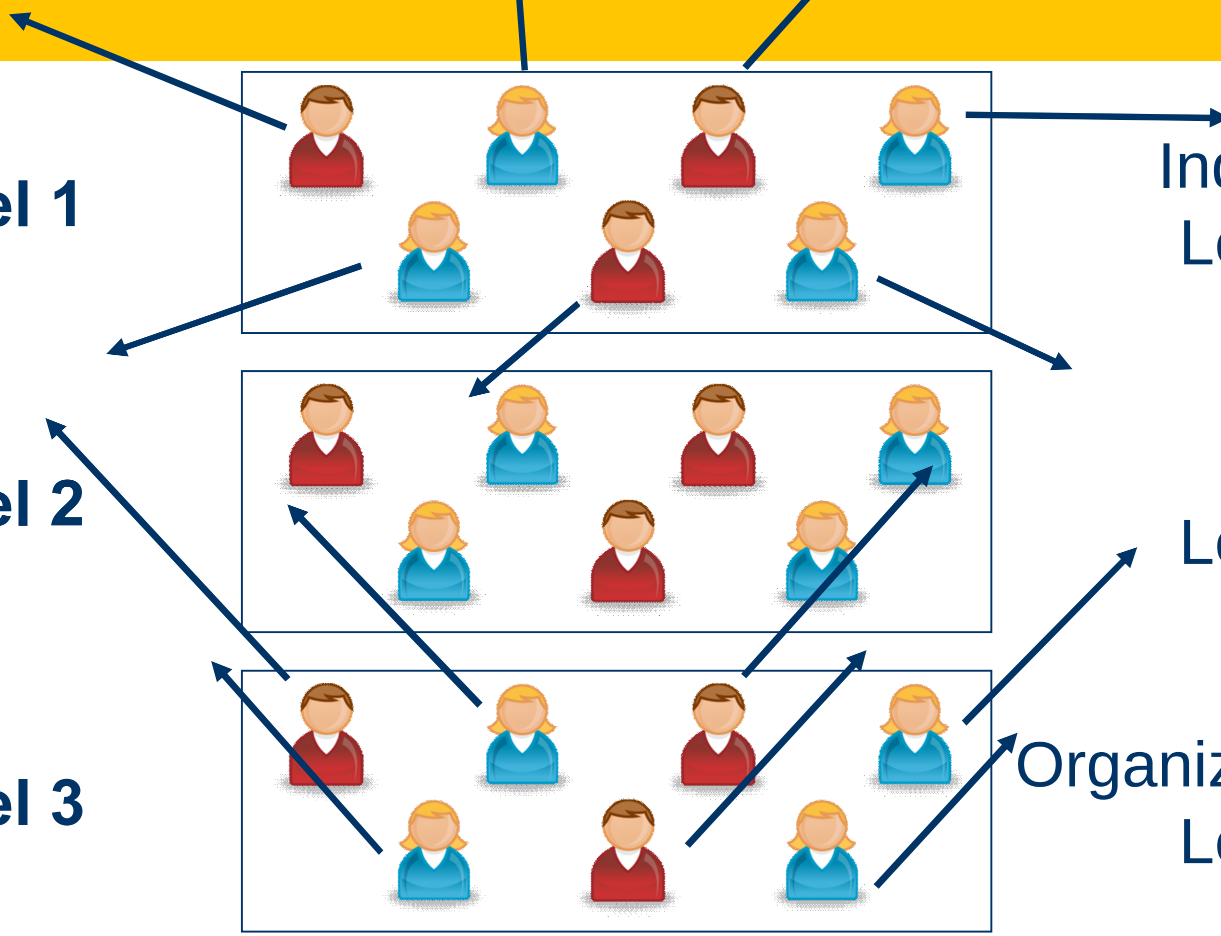
Correct Planning for Transformation



Level 1

Level 2

Level 3

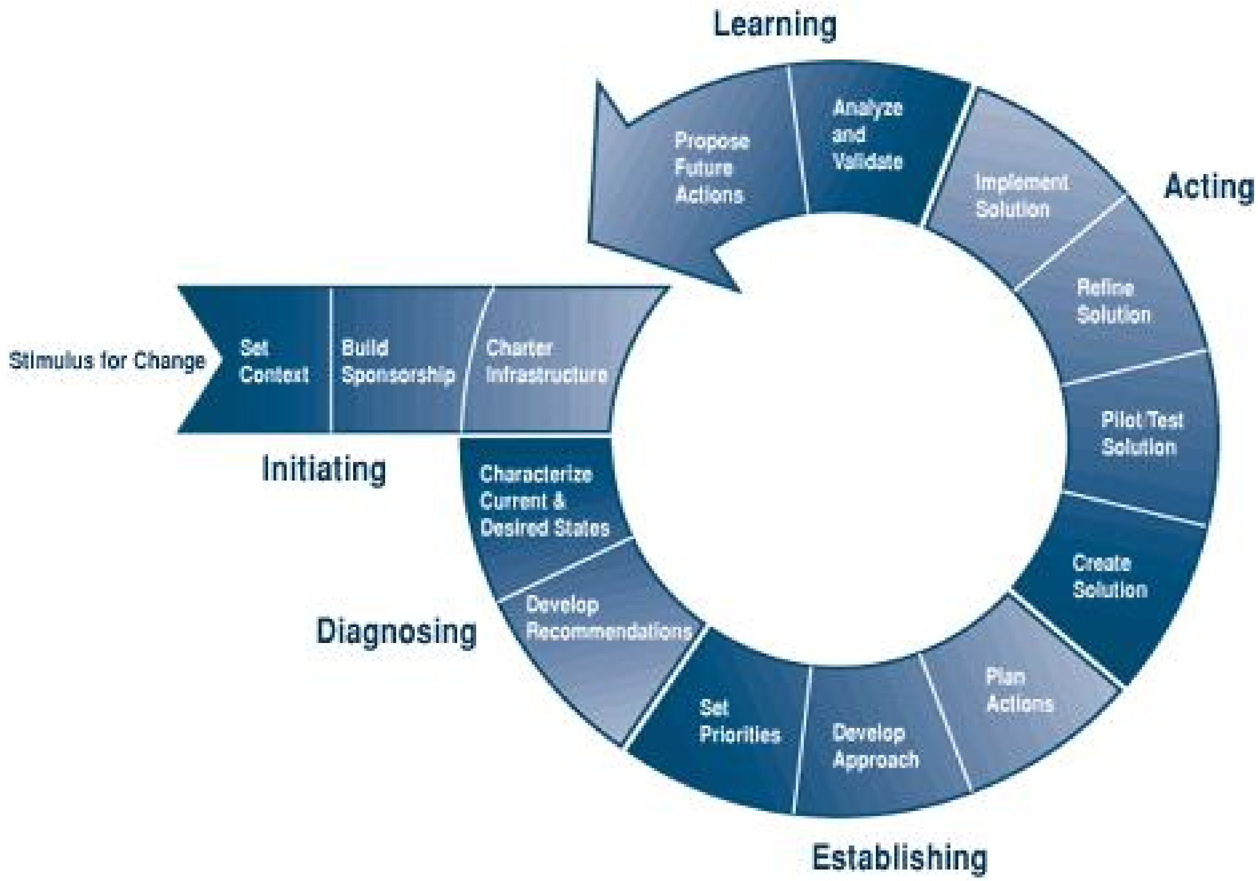
Individual Learning

Group Learning

Organizational Learning

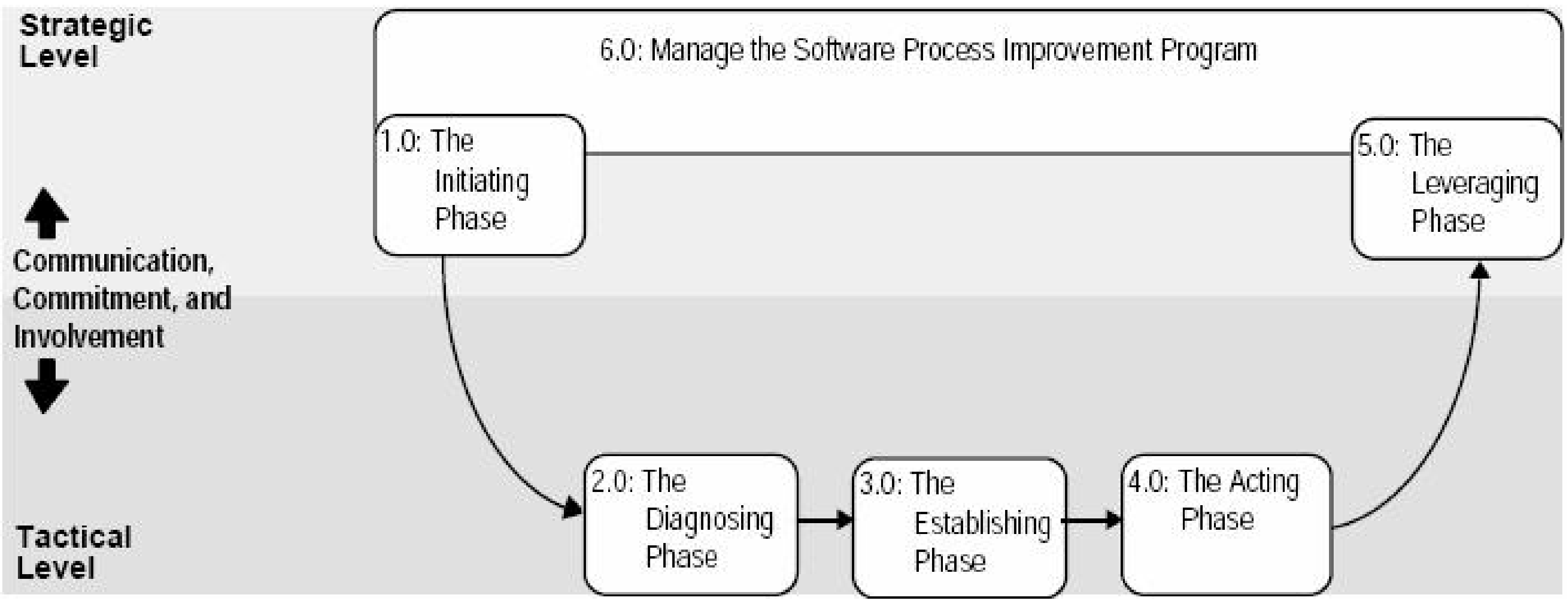
eXtreme Process Improvement

IDEAL



eXtreme Process Improvement

IDEAL



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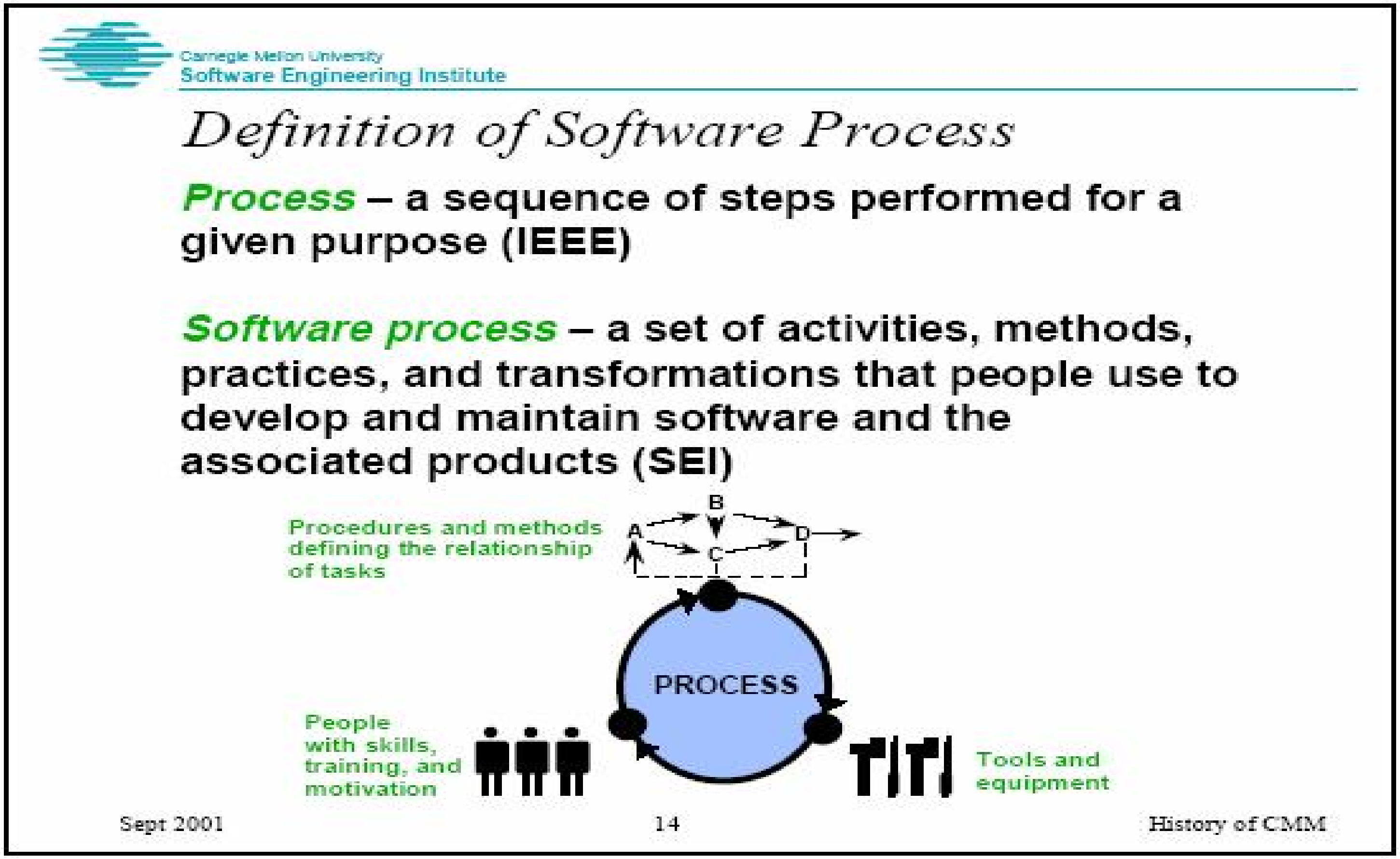

eXtreme Process Improvement

Tools are Just Tools!

Carnegie Mellon University
Software Engineering Institute

Recognized Adoption Issues

"70% of tools purchased by the organizations in the surveys are never used, other than perhaps in initial trial

25% are used by only one team or person within each organization

5% are widely used, but not to capacity. Perhaps only 10% of the capacity of the tool is used."

From Jerry Weinberg's informal tool survey, cited in *Quality Software Management vol 4: Anticipating Change*. Dorset House, 1997.

4

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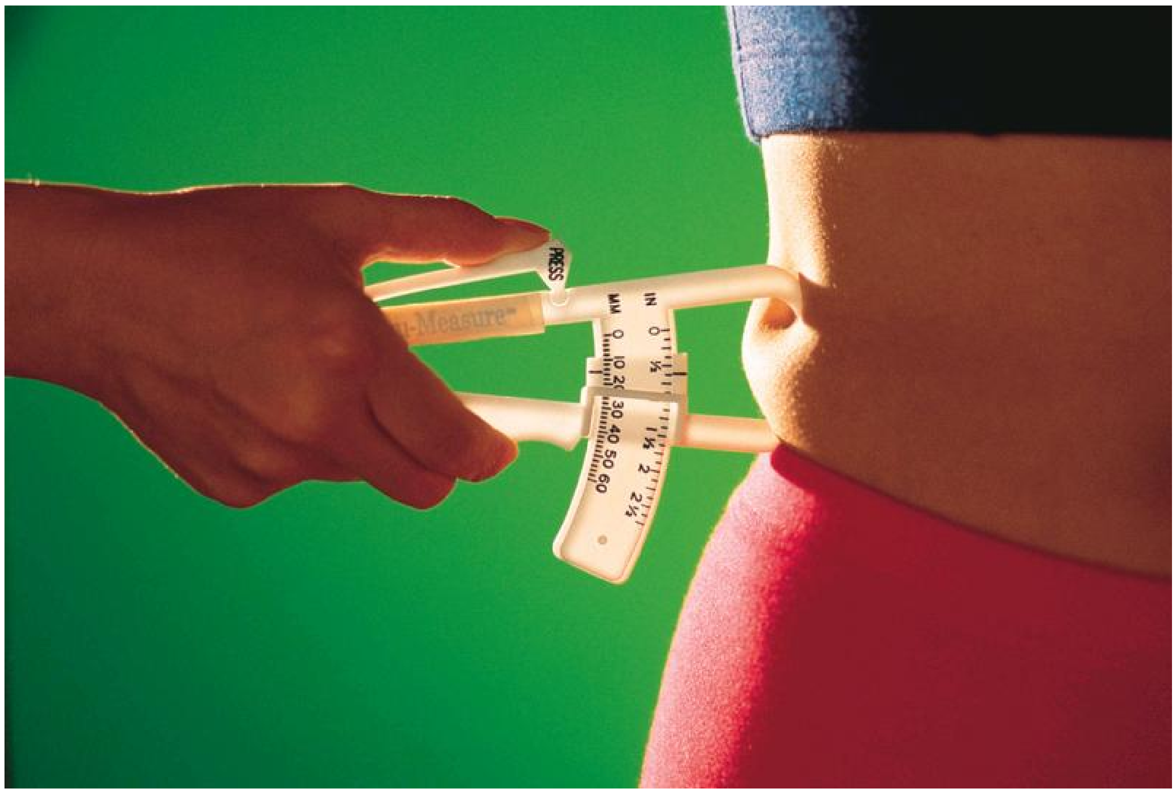
Sustainable Transformation

- Up or down!
- There is no ñLetôs stay hereò

eXtreme Process Improvement

Sustainable Transformation



eXtreme Process Improvement

Seven Success Factors for CMMI based Process Improvement

Orhan KALAYCI
orhan.kalayci@xpi.ca
November 2007

http://www.xpi.ca

CMMI Process Improvement – Its not a Technical Problem, it's a People Problem!

NDIA CMMI Technology Conference

November 15th, 2007

Rolf W. Reitzig

cognence inc
Improving Software Economics

sinesses...

- Run operations as if they were a franchise
  - Every business process is standardized
  - Employees can easily be successful by following the processes as outlined
  - Everyone knows how to perform their job
  - Tasks are performed similarly on a repeatable basis and improved based on experience

- A quality process will yield a quality product

ng Concepts

- Great businesses are not built by extraordinary people, but by ordinary people doing extraordinary things
- To achieve this, a system is absolutely essential – it becomes the tools people use to increase productivity, to get the job done in a way that differentiates
- **If you haven't orchestrated your business, you don't own it!**

Source: *The e-Myth Revisited,* Michael E. Gerber, HarperCollins Publishers, 1995

Role

- It's management's job to develop systems and tools and teach people how to use them
- Its the people's job to use the tools and to recommend improvements based on their experience with them
- There is no such thing as undesirable work, only people who view certain kinds of work as undesirable – create an environment in which doing certain things is more important than not doing them
- Management makes sure employees understand the idea behind the work they are being asked to do
- **Avoid "Management by Abdication"!**

Source: *The e-Myth Revisited,* Michael E. Gerber, HarperCollins Publishers, 1995

ring Business Model Philosophy

Process Management

OPF | OPD | OT

PM

Integrated Project Management

Project Planning

Project Monitoring and Control

Risk Management

Supplier Agreement Management

Engineering

REQM | RD | TS | PI | VER | VAL

Support

Configuration Management

Measurement and Analysis

Process and Product Quality Assurance

Decision Analysis and Resolution

...estment

- Organizations typically invest 2%-4% of their IT budget on engineering improvement
- Organizations engaged in an engineering improvement effort experience 50%+ gains in productivity and a 25%+ decreases in post-release defects
- Average ROI was 5:1
- Example: An IT department with a $100M budget spending $4M on SPI can expect a $20M gain in productivity over 2 years

inciples of SPI

1. Major changes to the software process must start at the top
2. Effective change requires a goal and knowledge of the current process
3. Software process improvement requires investment
4. Ultimately, everyone must be involved
5. Software process changes will not be retained without conscious effort and periodic reinforcement
6. Change is continuous

Source: Humphrey, W.S. *Managing the Software Process.* Addison-Wesley, 1989

cepts

1. To improve the software process, someone must work on it
2. Unplanned process improvement is wishful thinking
3. Automation of a poorly defined process will produce poorly defined results
4. Improvements should be made in small, tested steps
5. Train, train, train!

Source: Humphrey, W.S. *Managing the Software Process.* Addison-Wesley, 1989

Transformation

- Improvement models like CMMI build on organizational transformation theory to drive effectiveness.
- Thus, it is imperative to understand organizational transformation theory in order to implement a franchisable engineering system and improve results.

's Transformation Best Practices

1. Establish a sense of urgency
2. Create the guiding coalition
3. Develop a vision and strategy
4. Communicate the change vision
5. Empower employees for broad-based action
6. Generate short-term wins
7. Consolidate gains and produce more change
8. Anchor new approaches in the culture

Source: John P. Kotter, Leading Change, Harvard Business School Press, 1996

g a Sense of Urgency

- Progression to subsequent organizational transformation phases is difficult, if not impossible, unless most managers honestly believe that the status quo is unacceptable

e Guiding Coalition

- Successful transformations must be guided by a powerful coalition that can act as a team
- The coalition is needed because no one individual has the information needed to make all major decisions or the time and credibility needed to convince lots of people to implement the decisions

a Vision and Strategy

- Vision refers to a picture of the future with some implicit or explicit commentary on why people should strive to create that future.
- 3 purposes
  - Clarifies the general direction for change
  - Motivates people to take action
  - Coordinates the efforts of different people
- Must be conveyable in 5 minutes or less

ating the Change Vision

- The real power of a vision is unleashed when most of those involved in an enterprise have a common understanding of its goals and direction
- You cannot overcommunicate the vision!
- A common mistake by the guiding coalition is to assume the organization can quickly come to grips with the vision

g Employees for Action

- Major organizational transformations rarely happen unless many people assist
- Employees generally won't help if they feel relatively powerless

Short-Term Wins

- Major changes take time
- People need to see convincing evidence that the effort is paying off
- Focus on short-term wins raises the urgency level and ties the transformation effort to the vision and strategy

ing Gains/Creating More Change

- If the sense of urgency is lowered, critical momentum can be lost and regression follows
- Irrational and political resistance to change never fully dissipates
- Avoid the temptation to "take a break"
- Leadership must keep a long term focus on the vision and anticipated results

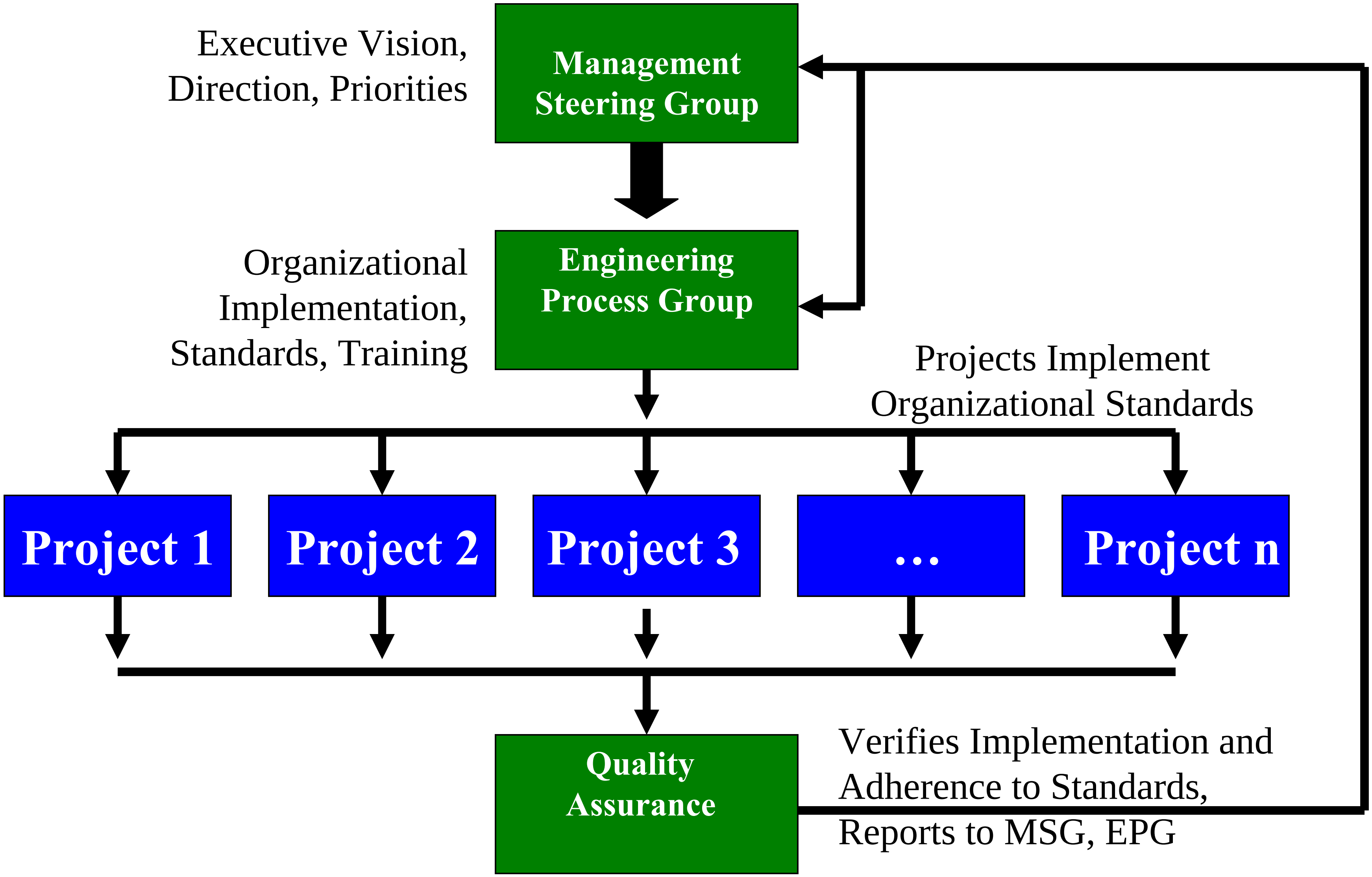
New Approaches in the Culture

- The goal is to permanently change the organization's shared values
- Cultural changes come last, not first
- Cultural norms are many times difficult to change
- Cultural shared values are extremely difficult to change
- Will the transformation effort transcend any particular individuals???

plement an Engineering System?

- Create an infrastructure that:
  - Leverages organizational transformation principles
  - Allows for senior management prioritization of engineering system implementation
  - Facilitates organizational buy-in and cooperation
  - Encourages cross-organizational communication
  - Reduces resistance of engineering system adoption through rewards based on independently verifiable achievement of management's expectations
  - Allows management visibility into the use of the franchisable engineering system

Transformation Infrastructure



tting the Stage

1. Establish Executive Sponsorship with the expectation it is <u>active</u>, not passive
2. Clearly tie the effort to business goals
3. Establish a guiding coalition (MSG/EPG) of movers and shakers from across the organization to drive the strategy, approach, and plan
4. Projectize the effort, assign a cost center, and treat it like a project with clear milestones and reviews
5. Conduct a comprehensive process, project, personnel, and financial appraisals to establish an organizational baseline
6. Tie implementation & adoption objectives to each individual's performance review

tablishing the System

7. Establish a measurement capability early, but don't overwhelm projects with data gathering requirements
8. Establish QA early to help guide and mentor, and to report engineering system adoption progress
9. Ensure project schedules going forward contain all the required elements to meet the effort's objectives
10. Either adopt processes & tools that meets your needs, or have the EPG design ones that are better suited
11. Projects tailor the franchise prototype, use them, and begin performing better!
12. Continue to monitor key business measures, execute QA, and conduct senior management reviews to drive urgency.

- The outcome will be an integrated, organizationally cooperative infrastructure that:
  - developed and deployed a franchised engineering system
  - is the foundation for a successful organizational transformation
  - facilitates engineering system improvement based on consensus priorities
  - provides an environment that supports project buy-in and adoption of improvements
  - communicates effectively across the organization
  - reports results to senior management

Questions?

cognence inc
Improving Software Economics

Change on Demand

Fast Track to Higher CMMI Maturity Levels: Lessons Learned from Five Initiatives

Cheryl White
Change Delivery Group

Presented to: NDIA

CMMI Technology Conference and Users Group
November 15, 2007

Overview

- Whether your organization is Level 1, Level 5 or someplace in between, achieving higher CMMI maturity levels is often a major investment in time, capital and other resources
- Realizing an acceptable rate of Return on Investment (ROI) often depends on accelerating the speed at which new processes can be implemented and adopted
- Here's how five organizations in commercial, government and outsourcing sectors outperformed industry benchmarks to increase process maturity in a remarkably short time

Agenda

- Why this Study is Important
- Five Case Studies
- Successes
- Common Practices
- Tips for Accelerating the Pace of Change

Reality

Historically, 75-85% of all organization transformation initiatives fail in whole or in part to deliver promised business benefits

For over 25 years studies confirm this.

Most recent studies: ProSci (2006), US Army (2007) and IBM (2006)

Outlook for the Year Ahead. . .

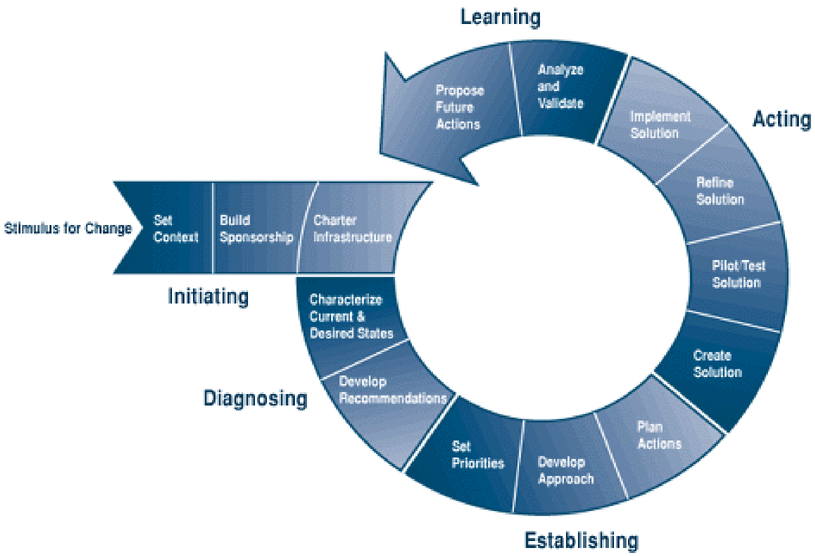
Each year, executives of approximately 90% of fortune 500 companies will undertake a business initiative that requires organization change

Some of these will be CMMI initiatives

Less than 25% of these projects will show a return on investment

The Problem is . . .

Although Change Management and Business Process Improvement have been around for more than 40 years, overwhelming evidence suggest that methods based on these models simply aren't reliable



There must be a better way

Alternative Methods

By using breakthrough process improvement methods, these projects beat the odds.

Here is what you can do to increase the success rate of your next project

Five Case Studies

The Projects

Commercial Sector

- 3 SE organizations within one IT department totaling 450 people, 1 VP, 6 directors, 19 projects

Outsourcing Sector

- 2 organizations within a 90 person outsourcing facility providing IT development services to the insurance and US defense industries

Federal Government

- 1 project within an agency of the federal government

All projects faced high risks

Project profiles

Case Study 1: Commercial Sector

- Initial assessment as L1
- Given 2 years to assess as L2
- 6 Change resistant, hostile project teams, demoralized management
- Previous consultant asked to leave due to non-performance
- 18 months into corporate project
- Committed internal resources
- Dwindling budget

Project profiles

Case Study 2: Outsourcing

- Initial assessment as L1
- Given 6 months to assess as L3 (Scampi Class B) by major client or lose contract
- Highly committed management
- No internal resources available
- Limited budget

Project profiles

Case Study 3: Agency of Federal Government

- Initial assessment as L1
- Need to make changes to comply with periodic GAO audits
- Leadership focus directed to other mission critical issues
- Initial lack of progress due to general lack of interest
- Small team of internal change agents
- Assisted by external consultants

What Went Right

Summary of Outcomes

Case Study 1:

- L1 to L3 in 18 weeks (Scampi B)
- Assessed as L3 11 months from project start (Scampi A)

Case Study 2:

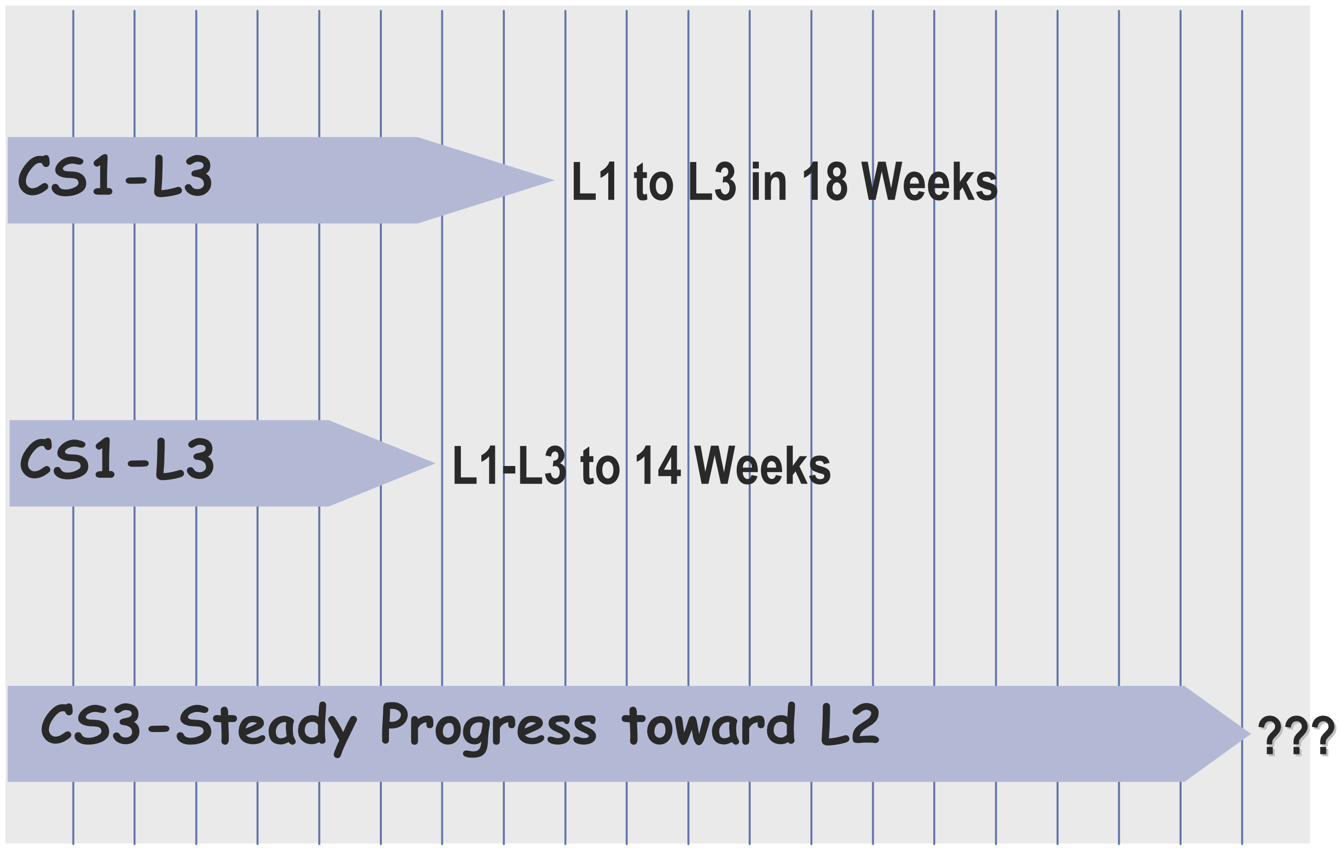
- L1 to L3 in 14 weeks (Scampi B)
- Assessed as L3 9 months from project start (Scampi A assessment grouped with other organizations)

Case Study 3:

- Continuous process improvement (validated by GAO audit)
- Date of L2 rating uncertain

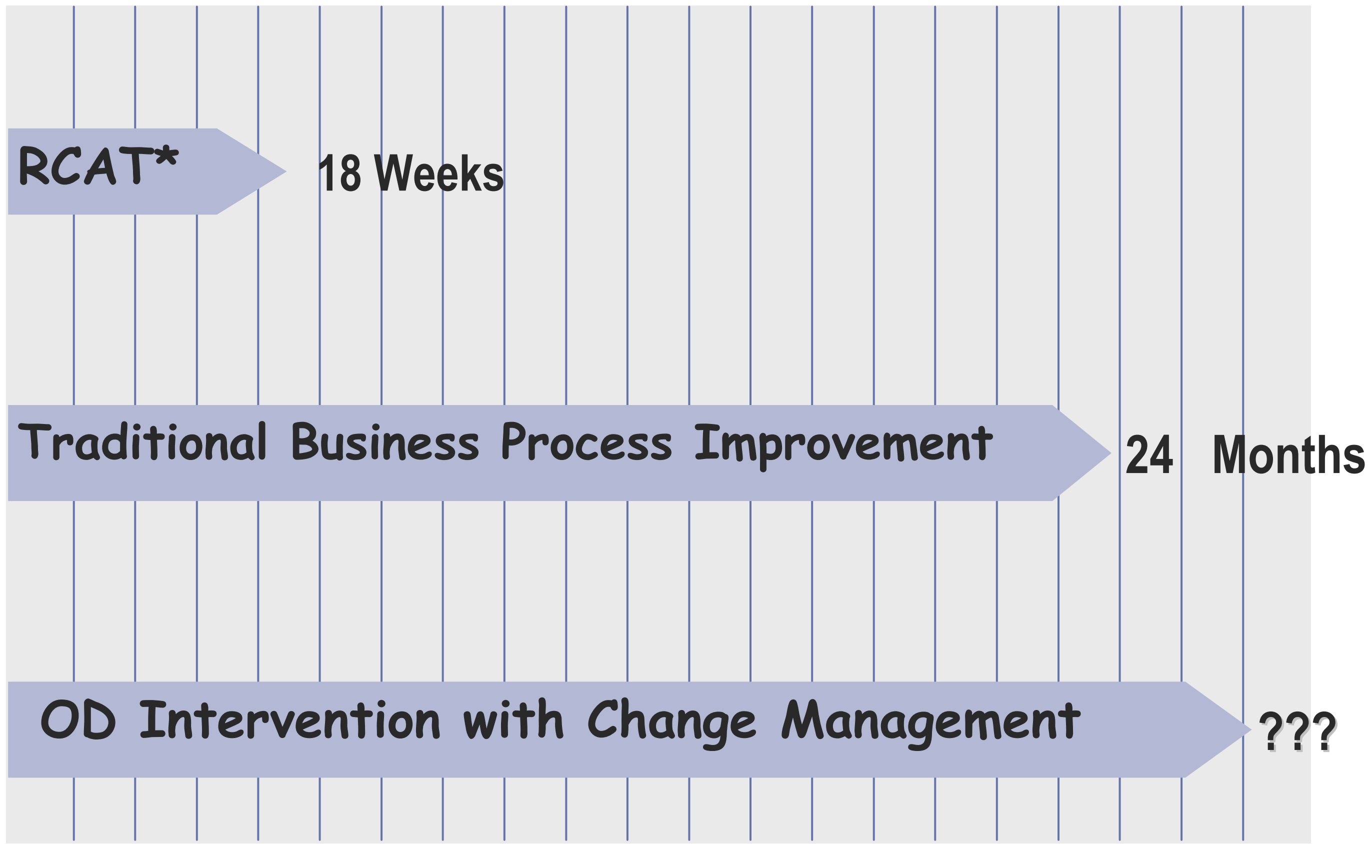
Comparison of Project Outcomes

Elapsed time to Sustainable Process Maturity



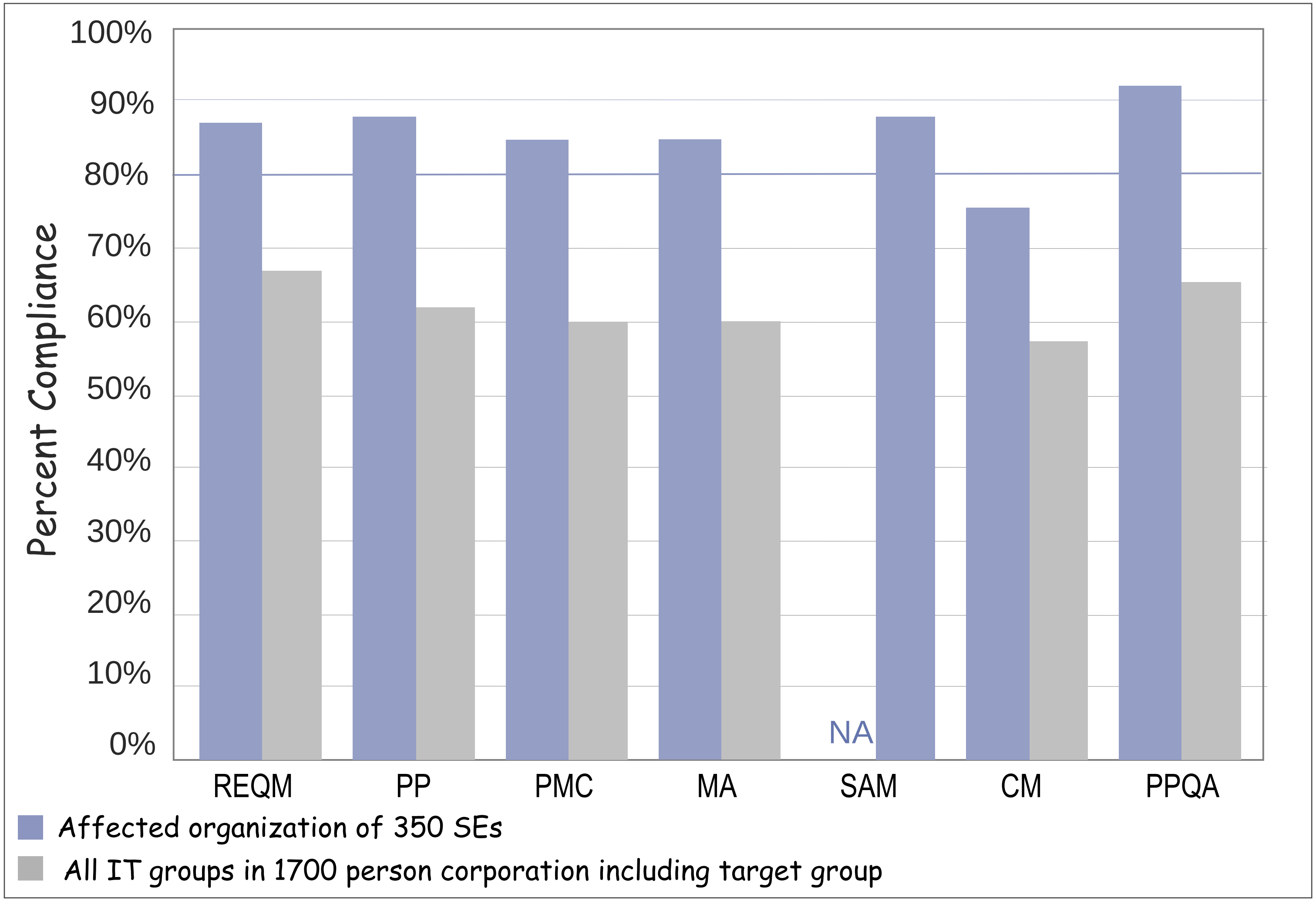
Case Study 1: Project Methodology vs Other Approaches Used During Initiative

Elapsed time to Sustainable Process Maturity



*RCAT=Rapid Change Attainment Team

Case Study 1: Project (after 6 Months) vs Total Organization After 24 Months (L2 only)



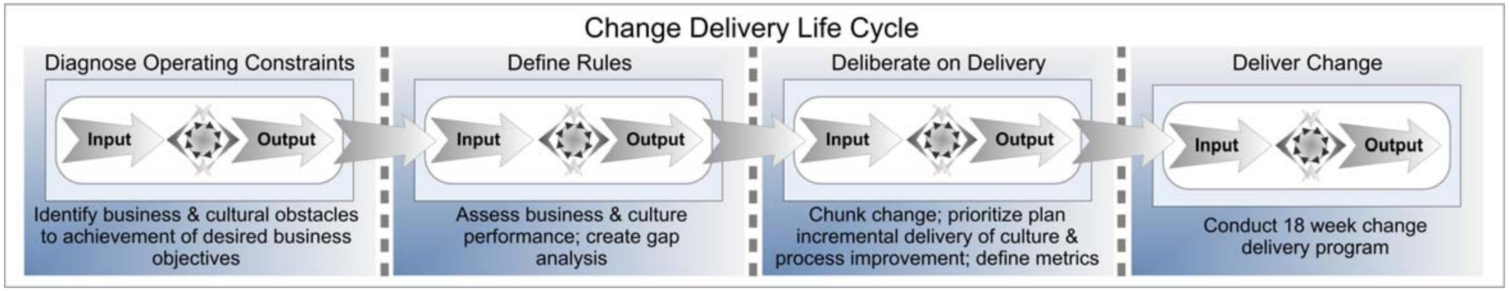
Common Practices

Common Practices

- Understood Risk
- Focus on what works best here
- Best performance and local best fit rather than on global best practices
- OSSP reverse engineered from multiple instantiated PDSPs
- Non-project work performed by consultants so the "real work" of business could go on throughout the transformation period

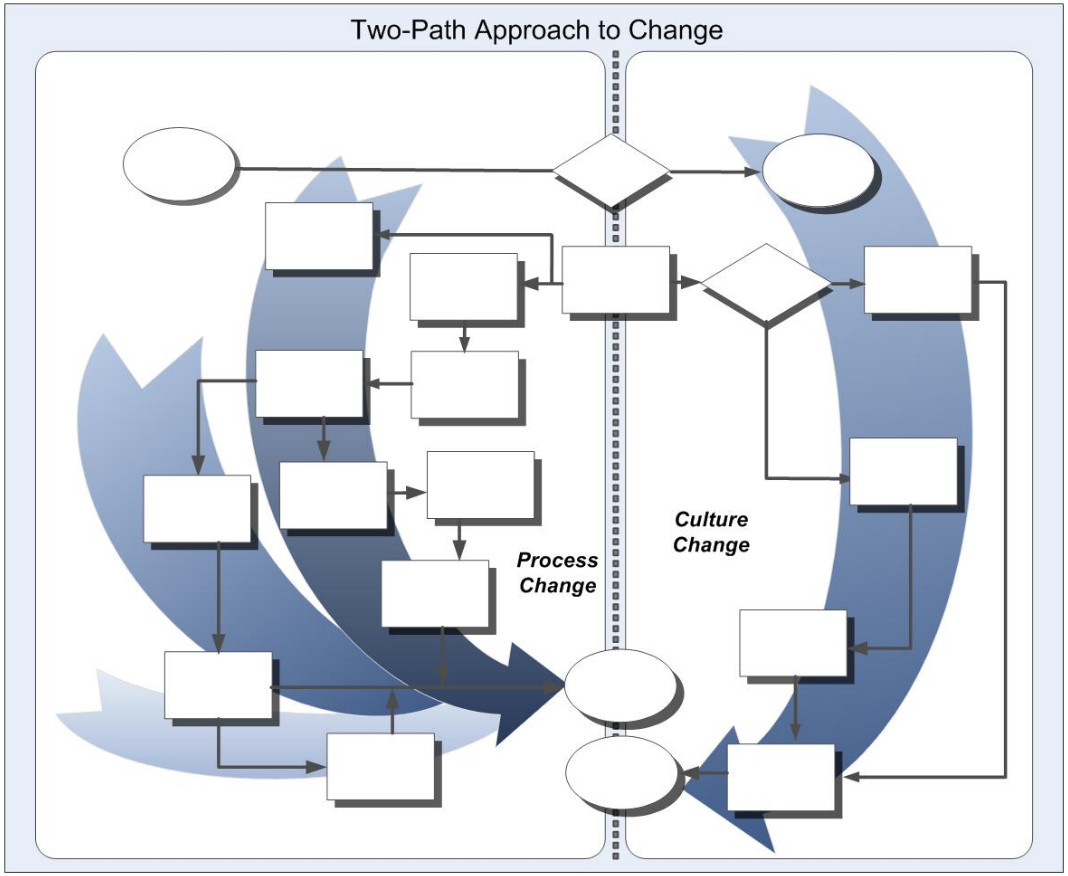
Common Practices

1 Use of standard methodology designed for Rapid Acceleration of Change



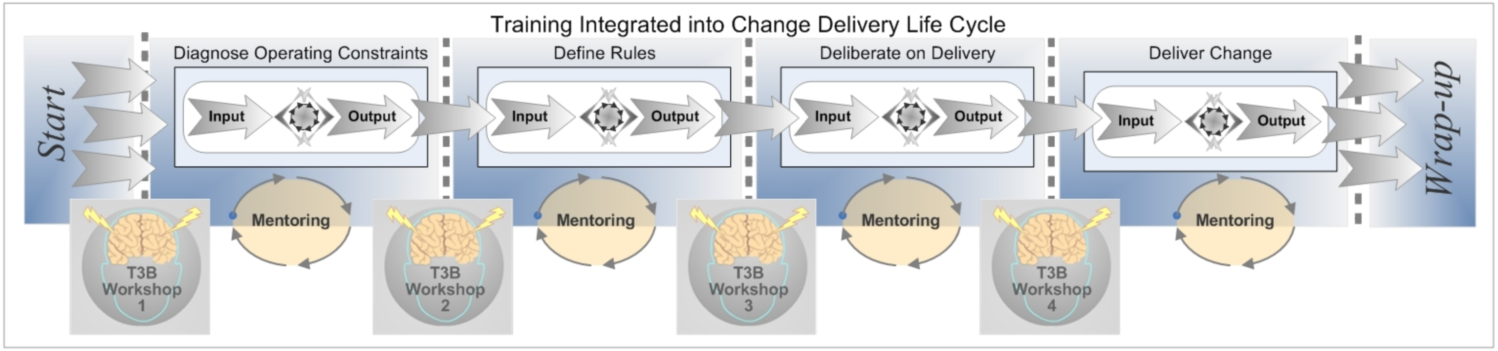
CMMI Change Agents who would never develop software without a PDSP frequently attempt organization change without a quantitatively proven transformation process

2. Culture Change concurrent with Process Change



Common Practices

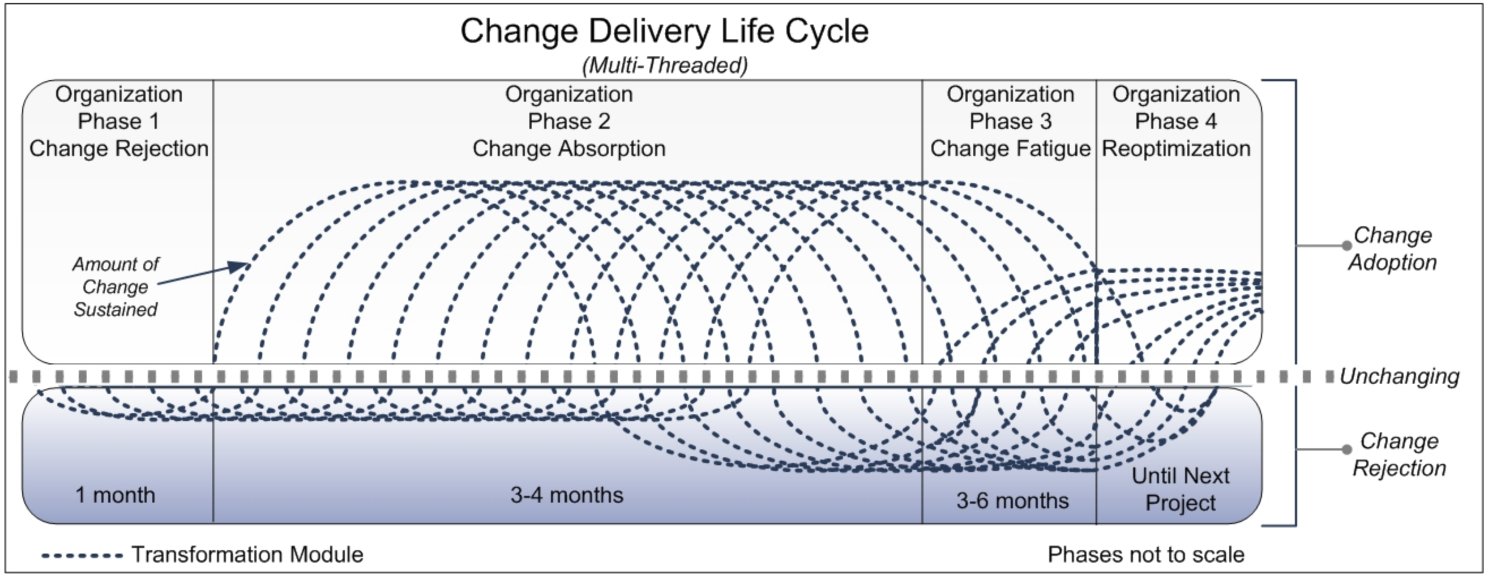
3 Organization training on how to reengineer corporate culture



4 Cultural assessments occur throughout the process improvement process

Culture coaching helped teams overcome barriers to change

5 Multi-threaded, iterative implementation cycles matched to the organization's natural change cycles



14 KPAs were institutionalized in 18 weeks (or less) once planning was complete

Accelerating the Pace of Change

Critical Success Factors

1 Expected corporate benefits aligned with actual CMMI benefits
2 Leadership was stable and remains engaged throughout initiative
3 One qualified consulting group led the change initiative
4 Consulting group had ready access to leadership throughout program
5 Core transformation team was trained on methods & tools used for culture change
6 4-10% organization work effort was committed to transformation activities

Contact Us for more information on these and other projects

Change Delivery Group
303.680.0895

www.changeperfect.com

Tips to Accelerate Pace of Change

Design business rules to be used: Understand the constraints of organization culture on employee behavior and design new business rules, processes, and technology to accommodate those constraints

Limit disruption to business: When it is a choice between business as usual and organization change, business always wins. Minimize disruption by implementing changes in tiny chunks

Include the right people on your team: Some people are keepers of culture. They can tell you "what works around here". Listen to them

Understand the comprehension of your sources: Typically, people who work in organizations do not explicitly understand the basic rules of culture or how culture encourages them to behave. Success depends on knowing more about culture than employees do

Design, develop and implement agilely: Organization culture is constantly changing. Tap into this "native" change ability to propel your project to success

Minimize negative culture responses during implementation: Small bits of change delivered incrementally over time cause less change resistance than larger chunks

Tips to Achieve Strategic Goals

Apply culturally reinforcing techniques: Culture will not push back when processes and technology support the status quo by conforming to existing organization rules

Limit your stay inside the organization and work fast: Organizations tolerate outsiders temporarily and attacks outsiders who refuse to comply. Most change agents are immune to attack for 6 months. After that they either leave or they become an agent of culture (rather than an agent for change)

Be suspicious of corporate rule books: Although culturally sanctioned behavior is pervasive and persistent, it is rarely documented. Most rule books document behaviors management wishes were present and want to enforce

Understand employee motivation: Persistent behaviors, especially crazy, dysfunctional or destructive behavior continues because culture rewards them

Be wary of initiatives under new management: New managers, especially those brought in to run a change program, often leave within 2 years. (Average time in position is 21 months). Plan your project accordingly

Presenter Bio

Ms White is a business enterprise architect specializing in the design and rapid implementation of IT and corporate transformation programs. With over 20 years experience in a wide range of organization transformation projects she has led strategic engagements resulting in the rapid implementation of CMMI, agile software development methods, ISO and six-sigma. She is the author of Change on Demand: The Science of Turbo Charging Change in Millennium Corporations (2007).

Raytheon
Space and Airborne Systems

CMMI, Configuration Management, and Baseball How to Score

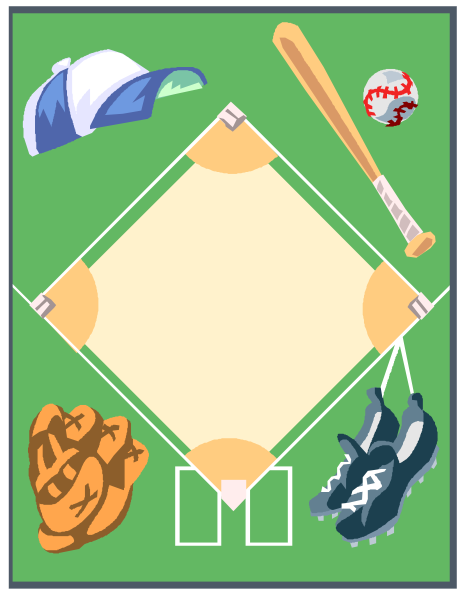
Julie Schmarje
Raytheon, Space and Airborne Systems (SAS)
November 15, 2007

ÅCMMI and Baseline Management

ÅCM and Baseline Management

ÅHow to Score

ÅSummary



- Describe the CM Baseline Management process and how it relates to:
  - CMMI
  - Program Execution
  - Baseball

- Describe the consequences of poor Baseline Management performance

ÅThe following terms are used in a generic manner:

- ï Baseline: An approved work product at a specific revision/version and date. A baselined work product is one that is released and controlled by CM.
- ï Configuration Baseline: A set of one or more baselined work products which represent the approved version of a predefined collection of work products.
- ï Change Request (CR): A request to change a baselined work product. The CR on programs could be an PCR, EO, SCR, SPCR, STR, etc.
- ï Configuration Control Board (CCB): The board that reviews and dispositions CRs against baselined work products. The board that performs this function could be called any one of a number of names ï ERB, CRB, SCCB, CCB, PRB, etc.

…ration Management?

ÅConfiguration Management (CM) is a process that establishes and maintains the integrity of work products.

ÅConsists of five functional areas:

ï **Planning** ï How will CM be performed on a project?

ï **Configuration Identification** ï How will configuration items be established and work products identified and what are their relationships within a product structure?

ï **Configuration Control** ï How will the work products and changes to the work products be controlled?

ï **Status Accounting** ï How will the status of the CM processes and program work products be managed and communicated?

ï **Reviews & Audits** ï How will the establishment and use of the CM processes be verified? How will the control of work products be verified?

Management? (1)

What is a baseline? What does it mean to "baseline" something?	Defining Baselines
What's in a baseline?	Identifying Baselines
How do I change what's in a baseline?	Controlling Baselines
What changed since yesterday? last year? last baseline?	Status Accounting of Baselines
Why should I believe the CM system?	Reviews & Audits of Baselines
What baselines are needed on my project?	Planning Baselines

What is a baseline & why do we have to manage it?

ne? (2)

Å Individual work products

- ï Baseline ñthe verbò
  - For individual work products, the act of releasing a work product into the configuration management system.
- ï Baseline ñthe nounò
  - The version or versions of the work product in the configuration management system.

Å Configuration Baseline

- ï Common Configuration Baselines include the Functional, Allocated, and Product Baselines.

…es Identified?

- **Individual work products have identifiers**
  - drawing number
  - document ID
  - code file version number
- **...and revision or version indicators**
  - revision letter (e.g., Rev. A)
  - version number, e.g., Version 1.2)
- **Configuration Baselines also have an identifier and a revision/version indicator**
  - Facilitates capture of different versions or snapshots of the collection as the work products, which comprise the collection, change
  - The CM information system should provide the status of a Configuration Baseline at selected points
    - by date
    - software build number
    - hardware serial number

Individual/Configuration Baselines must be identified to be effectively managed.

es Controlled?

- **An activity or event triggers a work product release**
  - Preliminary Design Review – Requirements
  - Critical Design Review - Design
- **For Initial Baseline:**
  - The baseline is audited to defined criteria for the type of work product
  - The configuration records and references are created in the CM system
  - The baseline is released in the CM System
  - The Configuration Baseline is established as identified in the CM Plan
- **For Changing Baselines:**
  - Evolving baselines are maintained in the CM System as the CCB authorizes changes to be incorporated into new versions of work products and Configuration Baselines.

Baselines are established and evolve in the CM System

line Management

ÅIn a CMMI-compliant CM process, baselines are

- ï Created (CM SP 1.3)
  - Authorized by an approval board (e.g., CCB)
  - Using controlled items in the CM system
  - Identified in the CM System, including the current configuration baselines
- ï Managed
  - Using specific baseline processes (CM GP 2.2, 3.1)
  - Within an established CM System (CM SP 1.2)
  - Controlled changes to baselines (CM SP 2.2)
- ï Verified
  - Audited baselines as theyôre established (CM SP 3.2)
  - Audited controlled baselines using CM records (CM SP 3.1, GP 2.9)

Good CM processes include Baseline Management

ement and Baseball (1)

Å**There are parallels between good Baseline Management and winning at baseball**

ï With a more mature understanding of processes and mature products (work products/players) it is easier to be successful (stable baselines/home runs)

ï Both have recognized industry standards

ï Team members must work together to be successful

ï New technologies/players can go through a try out period to identify strengths and areas to develop. For companies, this evolving set of work products are a company asset and should be baselined and managed.

ï Good management is essential to being successful

- Day to day
- Long term

…ement and Baseball (2)

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- **The following topics illustrate the similarities between the Baseline Management process and Baseball:**
  - Individual Baseline
  - Baseline Verification
  - Configuration Baseline
  - Product Baseline
  - Opponents
  - Results of Winning

ine

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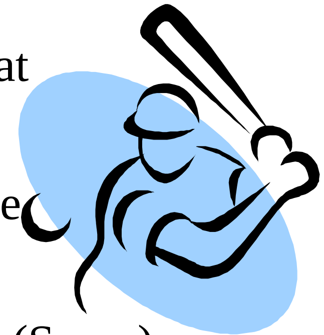
- **Configuration Management**
  - Identify Work Product
  - Create Work Product
  - Successful Peer Review
  - Successful CCB Review
  - Release (Baselined) Work Product

- **Baseball**
  - Identified player at bat
  - Player at First Base
  - Player at Second Base
  - Player at Third Base
  - Player at Home Plate (Score)



- **Comments**
  - Unless the Work Product is created (player able to advance to First Base), the process cannot begin
  - Unless its Peer and CCB reviewed and approved it canôt advance to release
  - There are legitimate ways to advance when the ball isnôt in play (stealing); however, not following the process creates problems (youôre out!)
  - Status Accounting data about Individual Baselines are similar to a playerôs statistics ï how it evolved and performed from inning to inning.

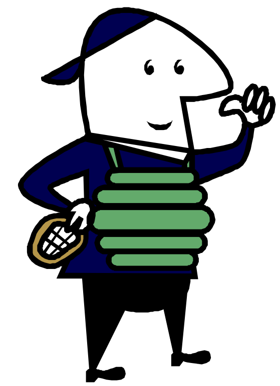
"Home Run" occurs when all steps are conducted smoothly

CMMI®

...tion

- **Configuration Management**
  - Baseline Audits
  - Process and Product Audits

- **Baseball**
  - Umpires



- **Comments**
  - Like baseball, Work Product Baselines are verified as they are established.
    - Audits are performed on work products prior to baseline (Home Plate Umpire)
    - Audits are performed on performance to the Baseline Management process (all Umpires looking to see if players are following the process)
  - Work Product and Configuration Baselines are audited to see if they are correctly controlled (Umpires and League)

Integrity of the process and products are verified

aseline

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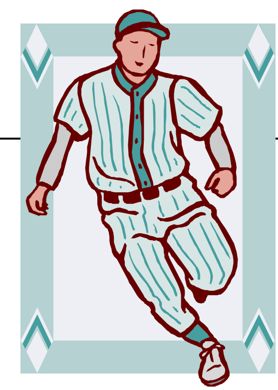
- **Configuration Management**
  - Identify Configuration Baselines
  - Create Configuration Baseline
  - Change Configuration Baseline

- **Baseball**
  - Innings: identified in Baseball Rules
  - First Inning
  - é . Ninth Inning

- **Comments**
  - As the Configuration Baseline evolves, the status accounting data is maintained (similar to the evolving score in baseball).
  - The score at the end of each inning is a snapshot in time



As the game progresses the score (Conf Baseline) evolves

CMMI®

Configuration Management
- Identify Product Baseline/TDP
- Control Product Baseline/TDP
- Deliver Product Baseline/TDP

Baseball
- Identify schedule for a game
- Conduct game
- Complete 9 innings

Comments
- The game (components of Product Baseline/TDP) is identified ahead of time
- The game is conducted and statistics kept about performance (Baseline Management and Status Accounting)
- The baselined product is delivered (final score). Winning depends on how successful the teams were in scoring/developing and controlling good work products.
- Errors have consequences, some impact the game more than others (the game could be prolonged/stretched out impacting period of performance)

As the game progresses errors can be disastrous to success

enting Success)

- **Configuration Management**
  - Insufficient Configuration Mgmt
  - No Defined Process
  - Poor Planning
  - Poor Execution
  - Poor Leadership
  - Poor Team Cohesiveness
  - Lack of Maturity
  - Lack of Training
  - Lack of Sufficient Resources

- **Baseball**
  - Opposing Team
  - Owners
  - Poor Team Execution
  - Poor Team Leadership
  - Poor Team Cohesiveness
  - Lack of Player Maturity
  - Lack of Player Training

- **Comments**
  - Many factors can hinder successful delivery of the Product Baseline/TDP on a program
  - With insufficient Configuration Management, it is difficult to successfully track the evolving Configuration Baseline and deliver the Product Baseline

ng

Å Configuration Management

- ï Ability to easily provide any Work Product Baseline or Configuration Baseline
- ï Repeat Customers
- ï New Customers/Programs

Å Baseball

- ï Happy Owners
- ï Loyal fans
- ï New fans
- ï Highly paid players/endorsement offers

Å Comments

- ï With successfully controlled baselines and deliveries, a company has a high probability of obtaining new programs and repeat customers.

CMMI®

- Ultimately, to win a baseball game, a team must be able to successfully score points and defend against their opponents
- Owners drive the success or failure of both the CM processes and Baseball teams. However, in the CM processes all participants are owners of the process, whereas only one rich guy owns the ball club.
- To be successful at delivering the correct product to your customer
  - A Baseline Management process must be defined and followed
  - Work Product Baselines must be identified, controlled, and managed
  - Configuration Baselines must be established and maintained
  - Product Baselines/TDPs created and delivered from the controlled Baselines

Acronyms

CCB	Configuration Control Board
CM	Configuration Management
CMMI	Capability Maturity Model Integrated
CR	Change Request
CRB	Change Review Board
EO	Engineering Order
ERB	Engineering Review Board
PCR	Program Change Request
PRB	Program Review Board
SCR	Software Change Request
SPCR	Software Problem Change Request
STR	Software Trouble Report
TDP	Technical Data Package

Improving Project Proposal Quality *via CMMI*

7th Annual CMMI® Technology Conference and User Group
11-15 November 2007

Chen Wang
Institute for Information Industry, Taiwan
www.iii.org.tw

1. The Problem
2. The Need
3. The Solution
    - 3.1 Mapping of CMMI
    - 3.2 Approach
    - 3.3 Constraints
4. Case Study
5. Summary

Congratulations

for your CMMI certification !

But…

you got to have ñA Projectòfirst !

However…

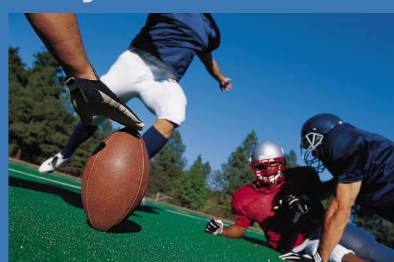
Proposal | Project Life Cycle

Project Kick-off

1. The process for setting-up a project is not well defined and managed.
2. The transition from proposal to project life cycle is not smooth and efficient.

Proposal	Project Life Cycle

Project Kick-off



Improving Processes

For

Better Proposal and Transition

Improving Processes

For

Better Proposal and Transition

Proposal to respond to RFP

Transition to transfer to project life cycle

Capabilities gained from CMMI

Characteristics of bad proposal

Mapping

Approach

Constraints

Your Customer

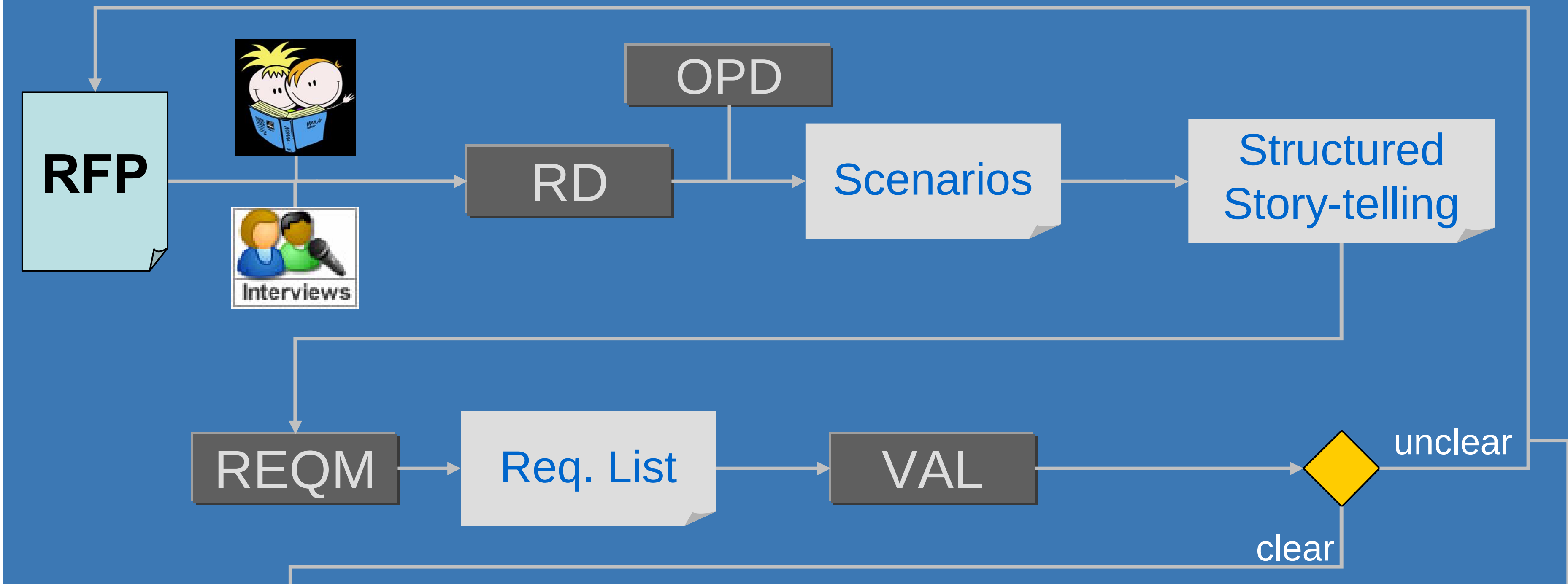
Your Proposal

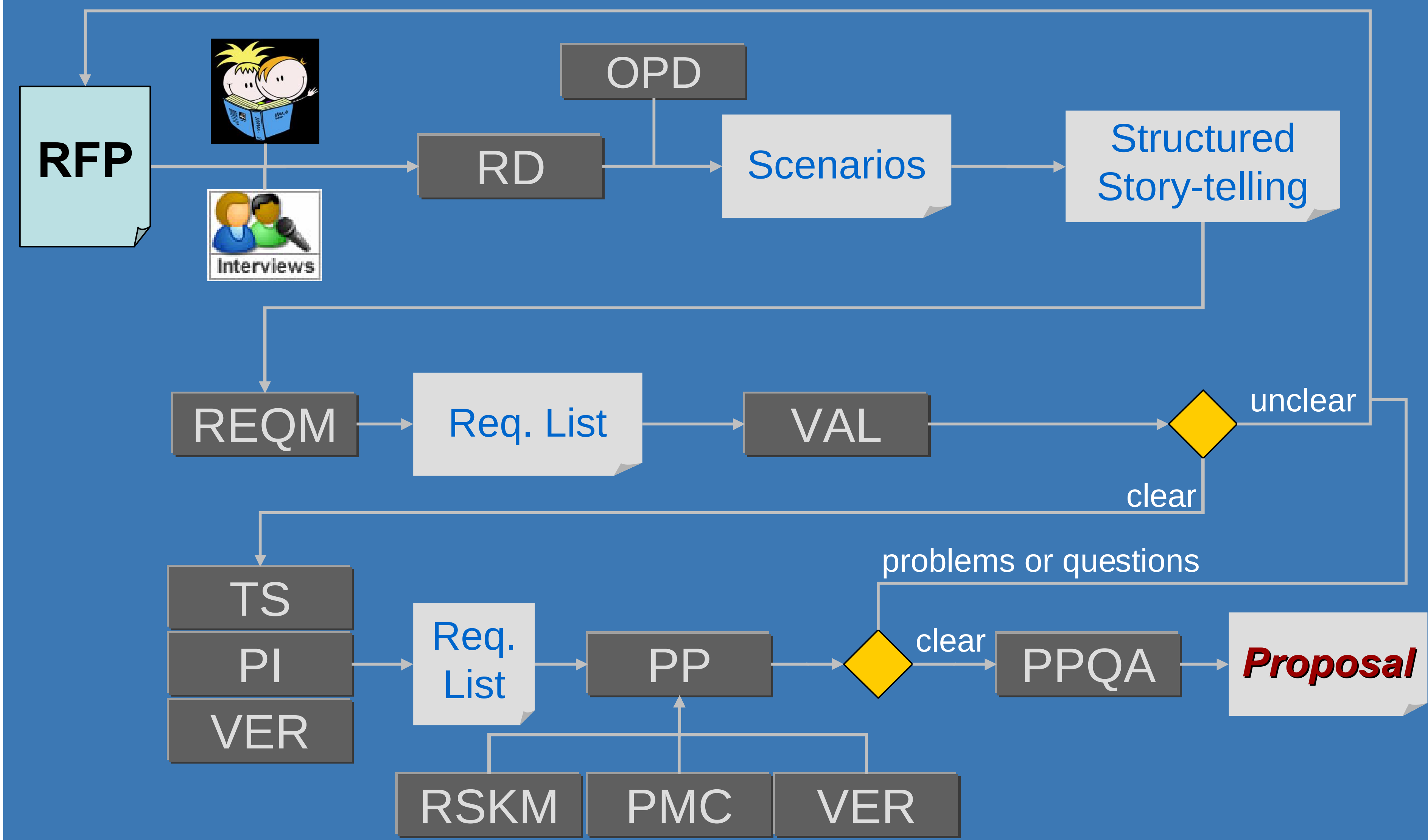
1. I am not sure and you sure donõt know syndrome.
2. Products/services are not tangible to customers.
3. Only functional requirements are addressed.
4. Hard for customer to know project status.
5. Not addressed from a ñserviceò viewpoint.

Characteristics of bad proposal

The ñight versionò of these PAs

1. Not Sure syndrome.	RD	REQM	VAL	PPQA
2. Not tangible.	RD	REQM		
3. Only functional req.	RD	REQM	PP	
4. Hard to know status.	PMC	PP	RSKM	
5. No ñserviceò viewpoint.	RD	OPD		


RFP
Interviews
RD
OPD
Scenarios
Structured Story-telling
REQM
Req. List
VAL
unclear
clear


RFP
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RD
Scenarios
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REQM
Req. List
VAL
unclear
clear
TS
PI
VER
problems or questions
Req. List
PP
clear
PPQA
Proposal
RSKM
PMC
VER

More applicable for :

1. New or less familiar domain
2. Quality-oriented acquisition
3. Service-oriented viewpoint
4. Demanding, new or smart customer
5. Strategic customer
6. Fair solicitation environment

RFID Application

What we are good at

What customer wants

RFID-enabled gas tank
life cycle management solution

What we are good at
: RFID Application

RFID-enabled gas tank
life cycle management solution

More applicable for :

1. **New or less familiar domain**
2. **Quality-oriented acquisition**
3. **Service-oriented viewpoint**
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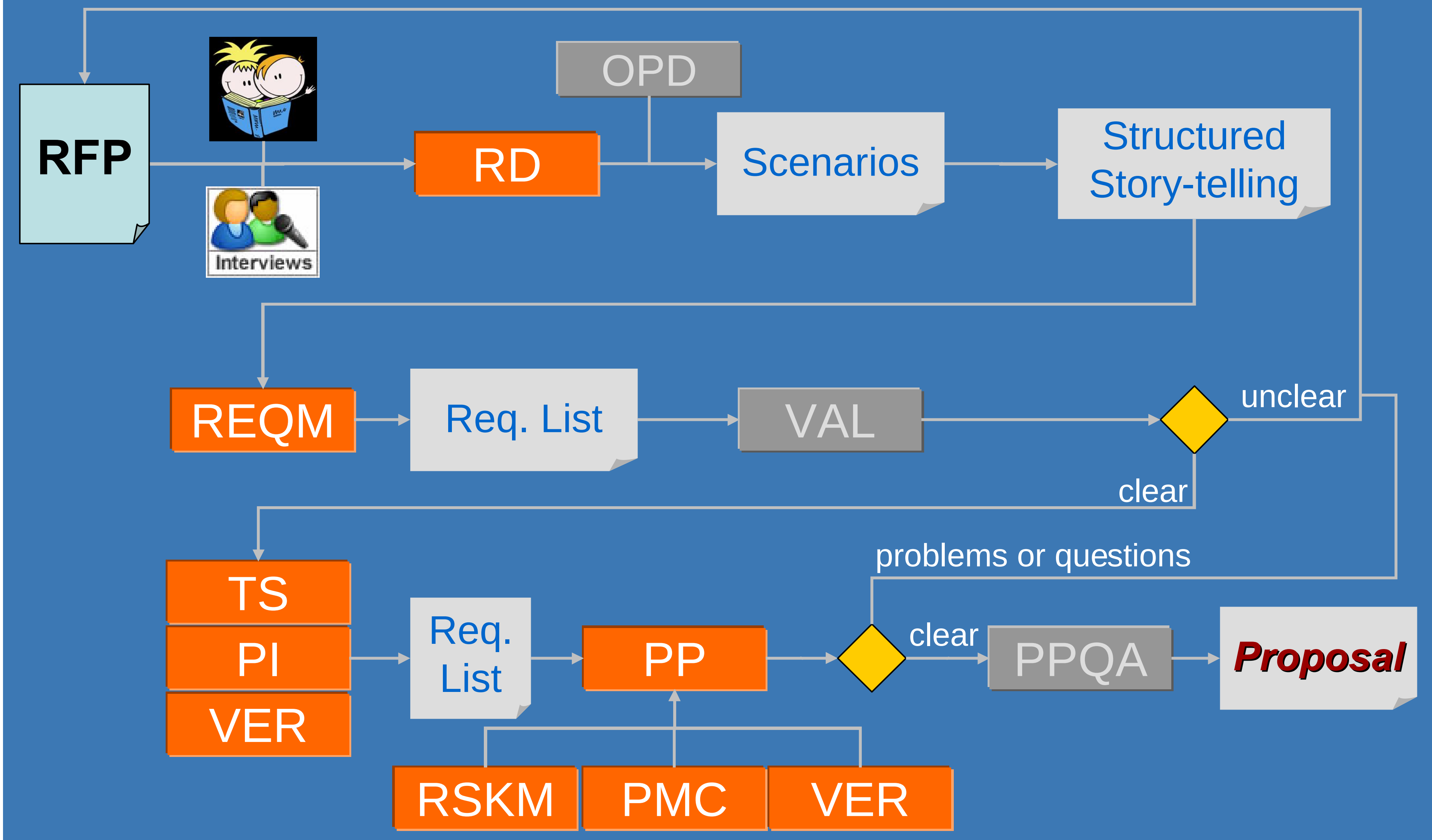
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problems or questions
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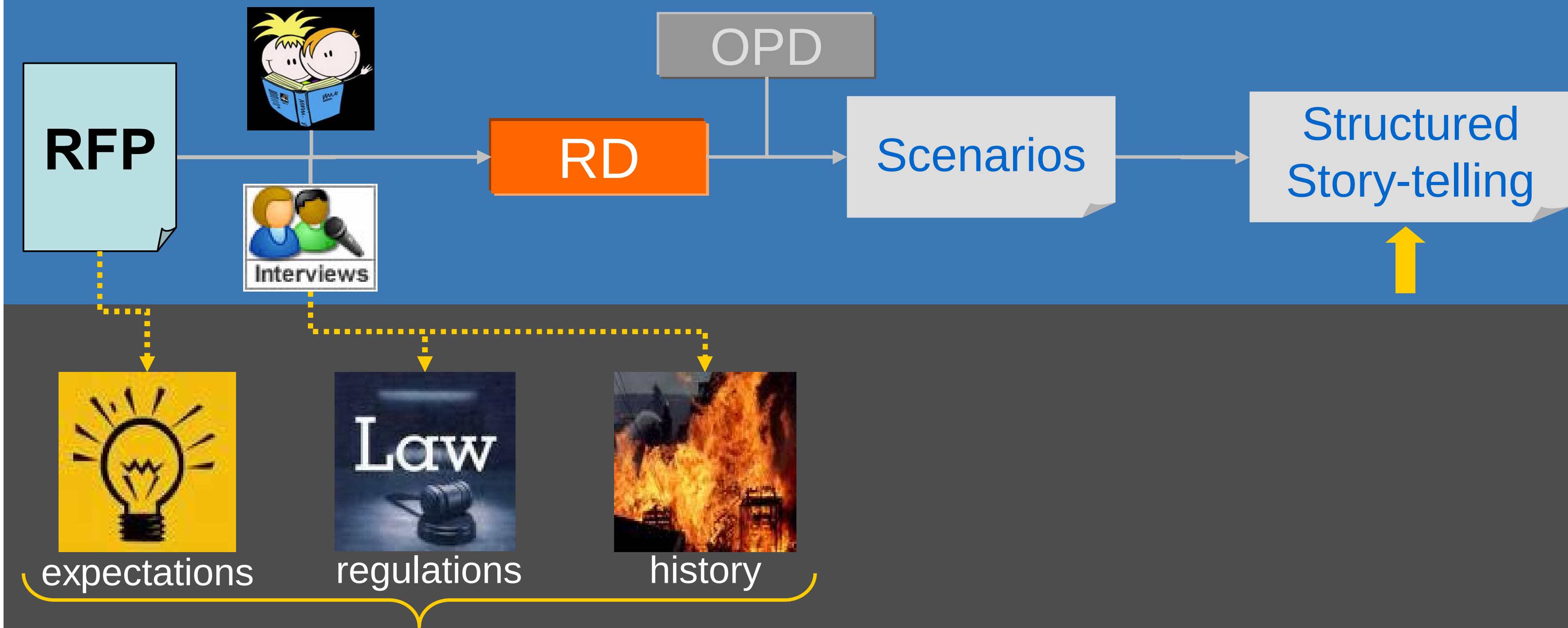
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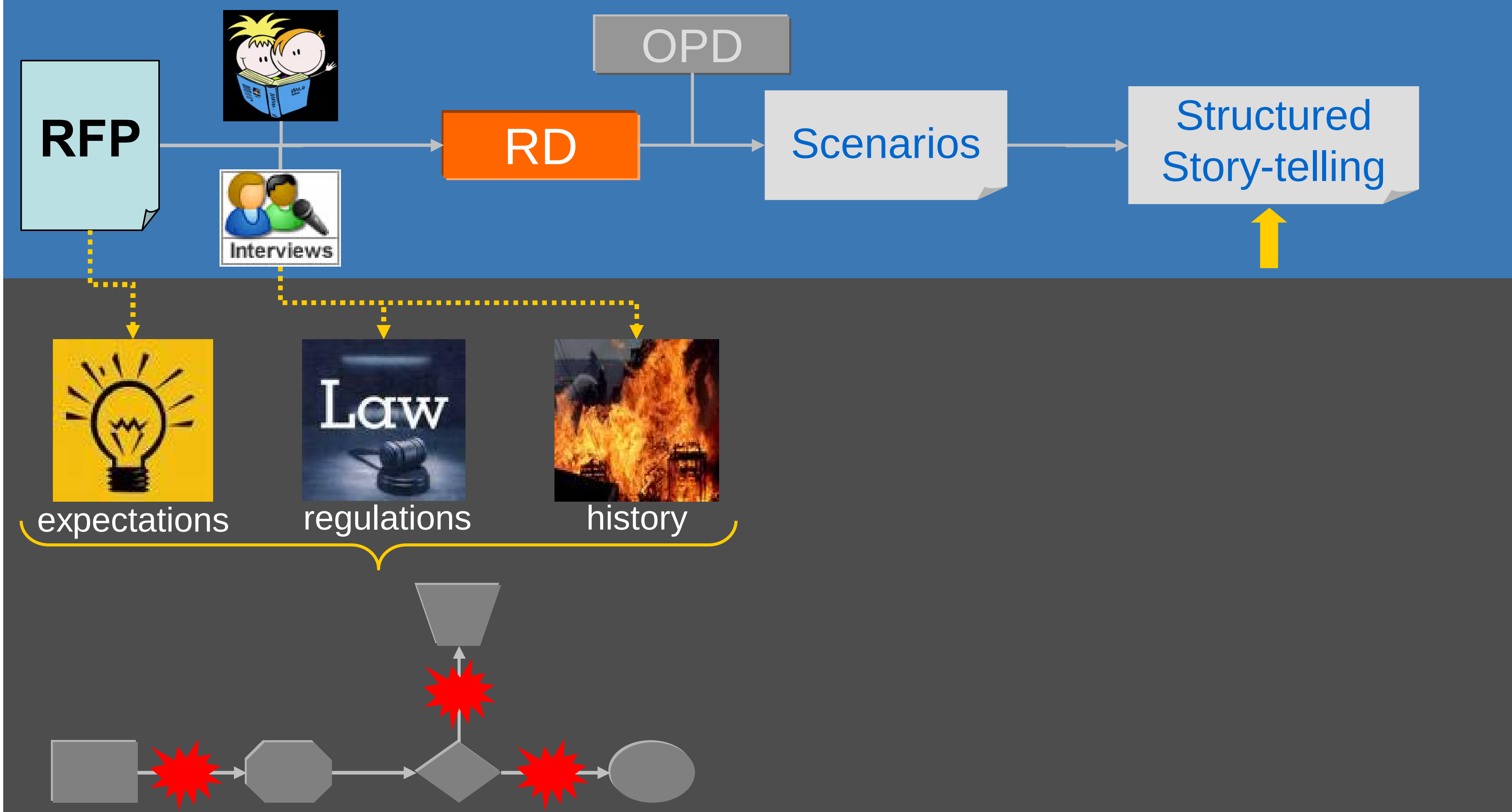
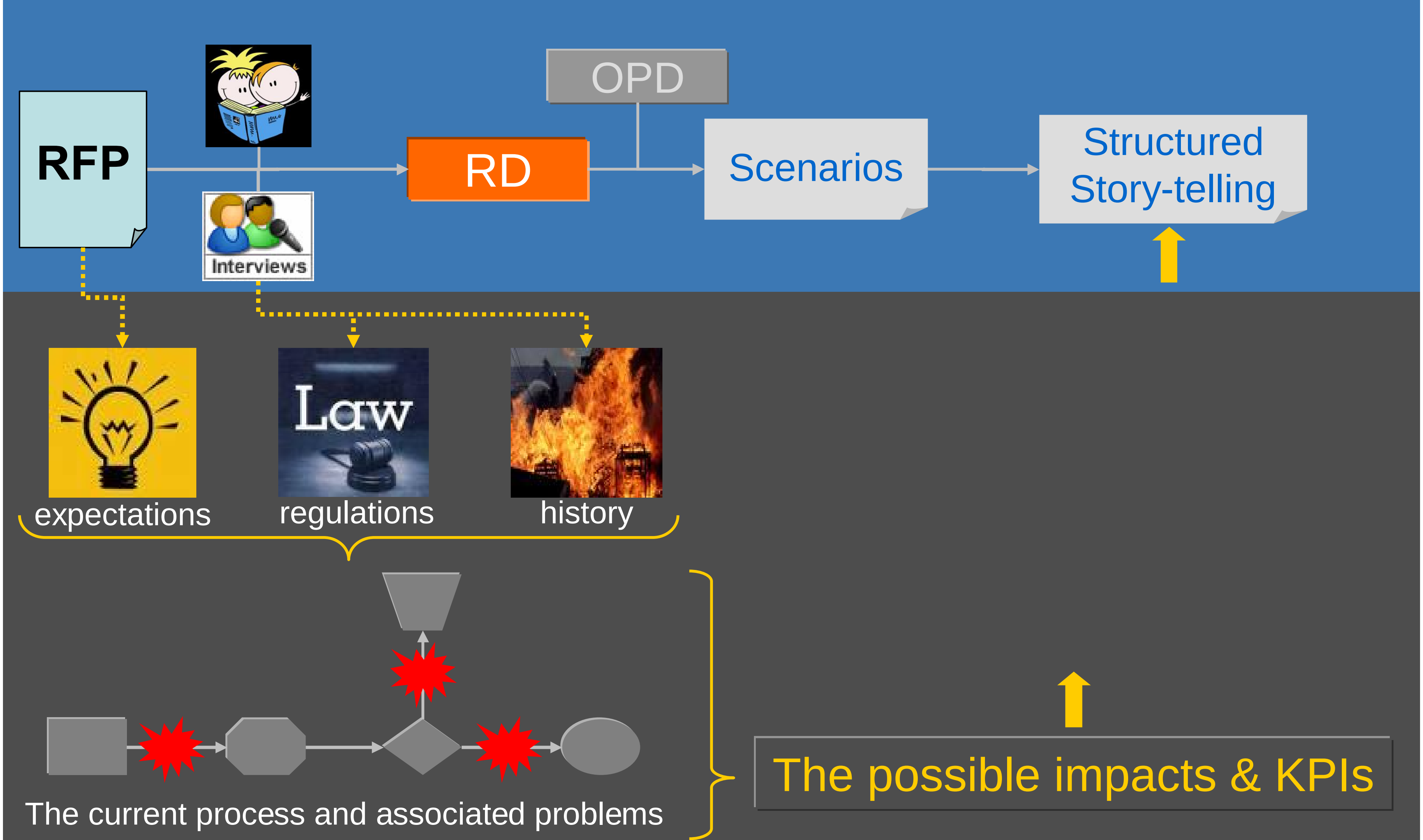
Law
expectations
regulations
history



The current process and associated problems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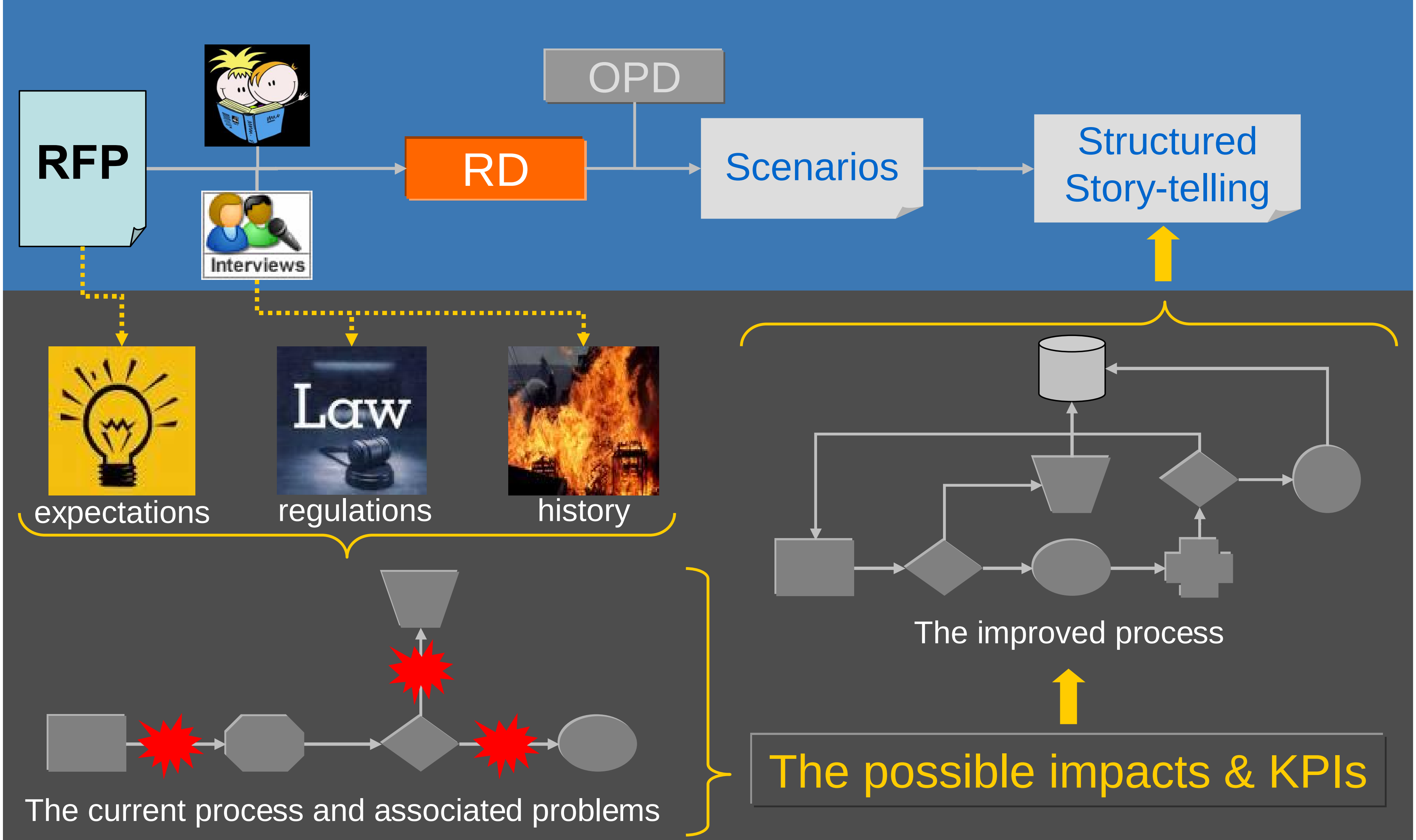
The current process and associated problems
The possible impacts & KPIs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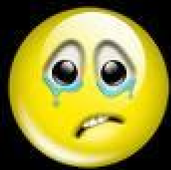
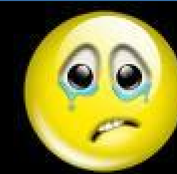
The improved process
The possible impacts & KPIs
The current process and associated problems

For the r̃gas tank management systemòcase :



But customer was amazed that we really did our homework and came up with a very practical solution.

For the ñgas tank management systemòcase :



But customer was amazed that we really did our homework and came up with a very practical solution.

For other cases (2 projects with software only, 3 systems with hardware and software) :

With this approach, you have the advantage of :

1. Really talking to your customer
2. Getting early stakeholders involvement
3. Thinking with a product life cycle viewpoint
4. Formulating a practical solution
5. Giving you a solid basis to reject the project or bargain for resources
6. Providing smooth and efficient transition to project execution
7. Having a process to follow for responding and interacting with customer

But there are some downside to it :

1. Interacting with customer may be a hard work
2. Teaming is not easy at this early stage
3. Good training is needed for this approach
4. It takes longer time for the proposal

Q & A

A Framework to Manage and Evaluate Remote Software Testing Using the CMMI for Services Constellation

Dr. Aldo Dagnino

CMMI Technology Conference and User Group

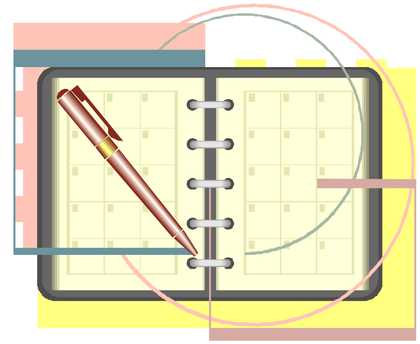
November 12-15, 2007

Hyatt Regency Tech Center, Denver, CO

Acknowledgements

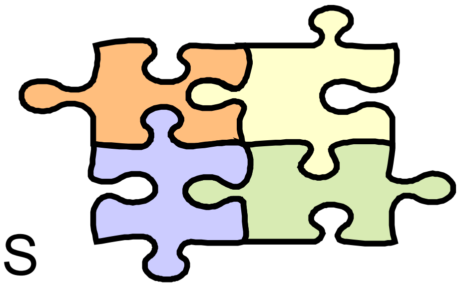
- This work was developed for the SAS Institute, a private FORTUNE 100 Software Development Organization based in Cary, NC
- Process presented was used during the development and release of two SAS Products for the Manufacturing Solutions Group in 2006

Agenda



- Introduction
- Geographically Distributed Product Development and Service Delivery
- Analysis of a Real-world Case Study
- Use of SAM PA for Product Development and Service Delivery
- Conclusions

d Development Scenario at SAS Manufacturing Solutions Group



- Software development typically driven from the US
- Remote development organizations located in India
- System/Integration Software Testing performed in India

- Product Management owns product roadmap and is located in US
- Senior Management for Development organization located in US
- Consulting Group responsible to customize and implement software solutions in the field

Geographic Distribution

- Software (Product) Development
  - Project Management
  - Development Manager
  - 2/3 Development Team

US

  - 1/3 Development Team

India

- Software Verification
  (System and Integration Testing)

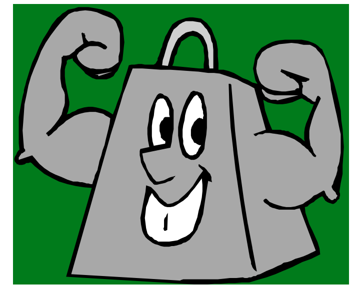
India

Improve Collaborative Development and Service Delivery

- Consulting Group
- Product Management
- Release Engineering
- R&D Senior Mgmt

US

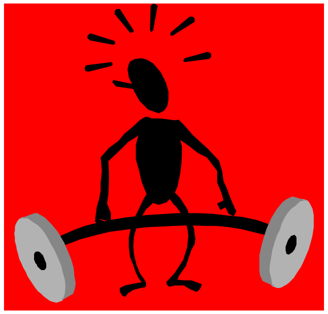
Findings CMMI Internal Appraisal – 1 –



- Strengths
  - **Organizational policy to manage external suppliers exist**
  - **Supplier Agreements for COTS products are developed**
  - **COTS products are evaluated against requirements**

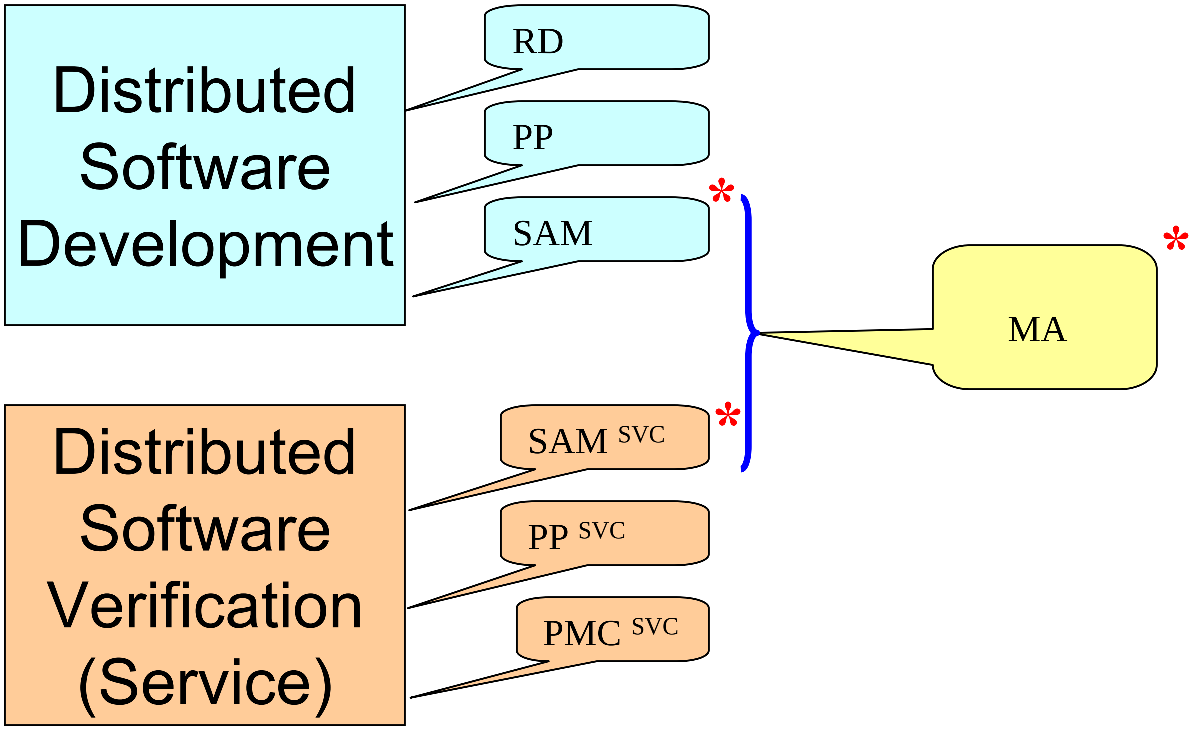
  - **Supply Chain Management handles the purchasing of commercial components for HW, SW and contractors**
  - **All teams use common RE, CM, and Defect Tracking tools**

Findings CMMI Internal Appraisal – 2 –



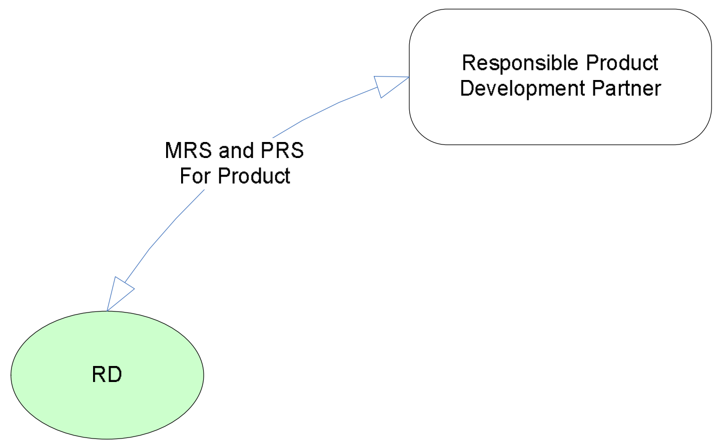
- Weaknesses
  - **No organizational policy/procedure to manage remote product development**
  - **No organizational policy/procedure to manage remote service delivery (Testing)**
  - **No formal collaboration agreements are established with remote teams**
  - **Transition of work products (and services) provided by remote organization perfomed in informal manner**

CMMI Practices

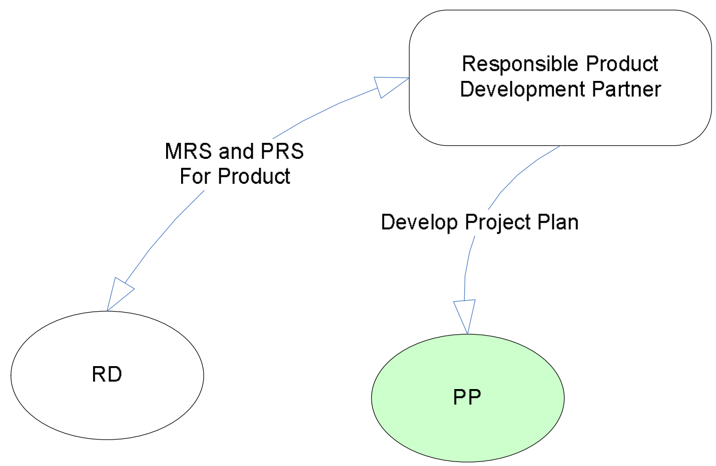


* **Note:** SAM for Product Development and Service Delivery and MA will be the focus of this presentation

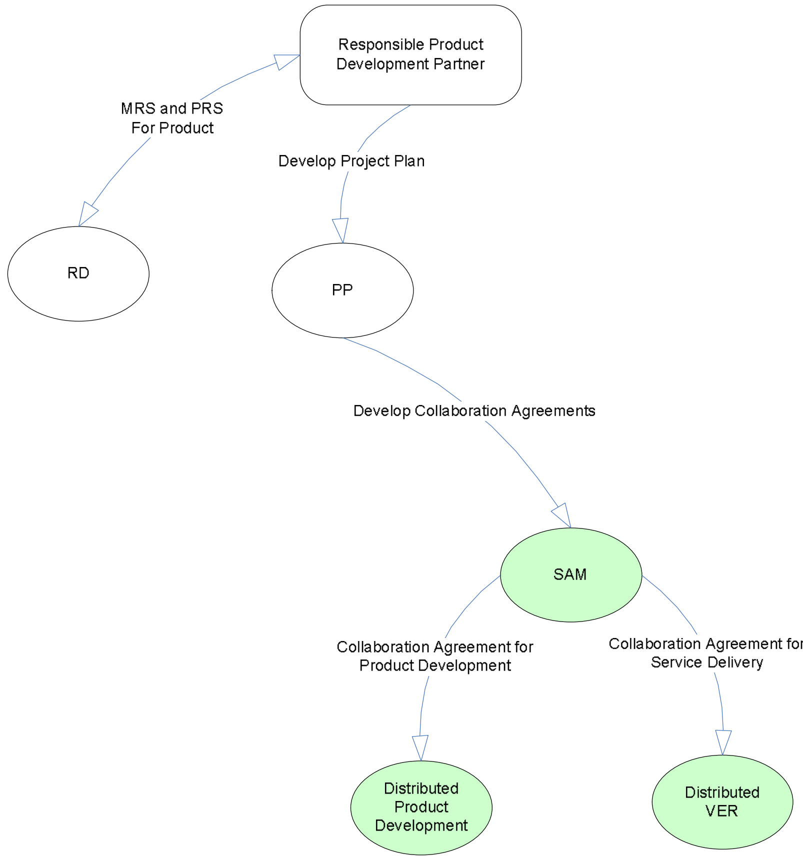
Process Area Relationships Stage 1



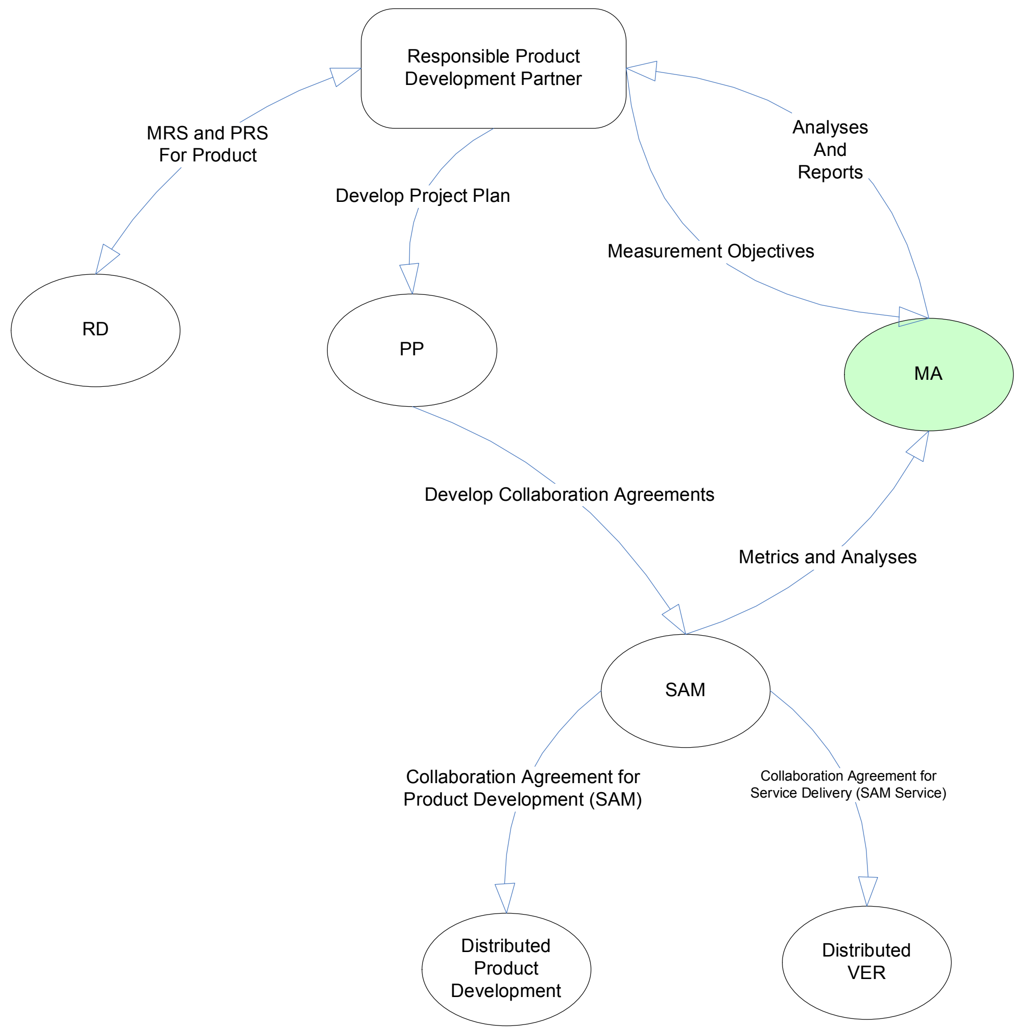
Process Area Relationships Stage 2



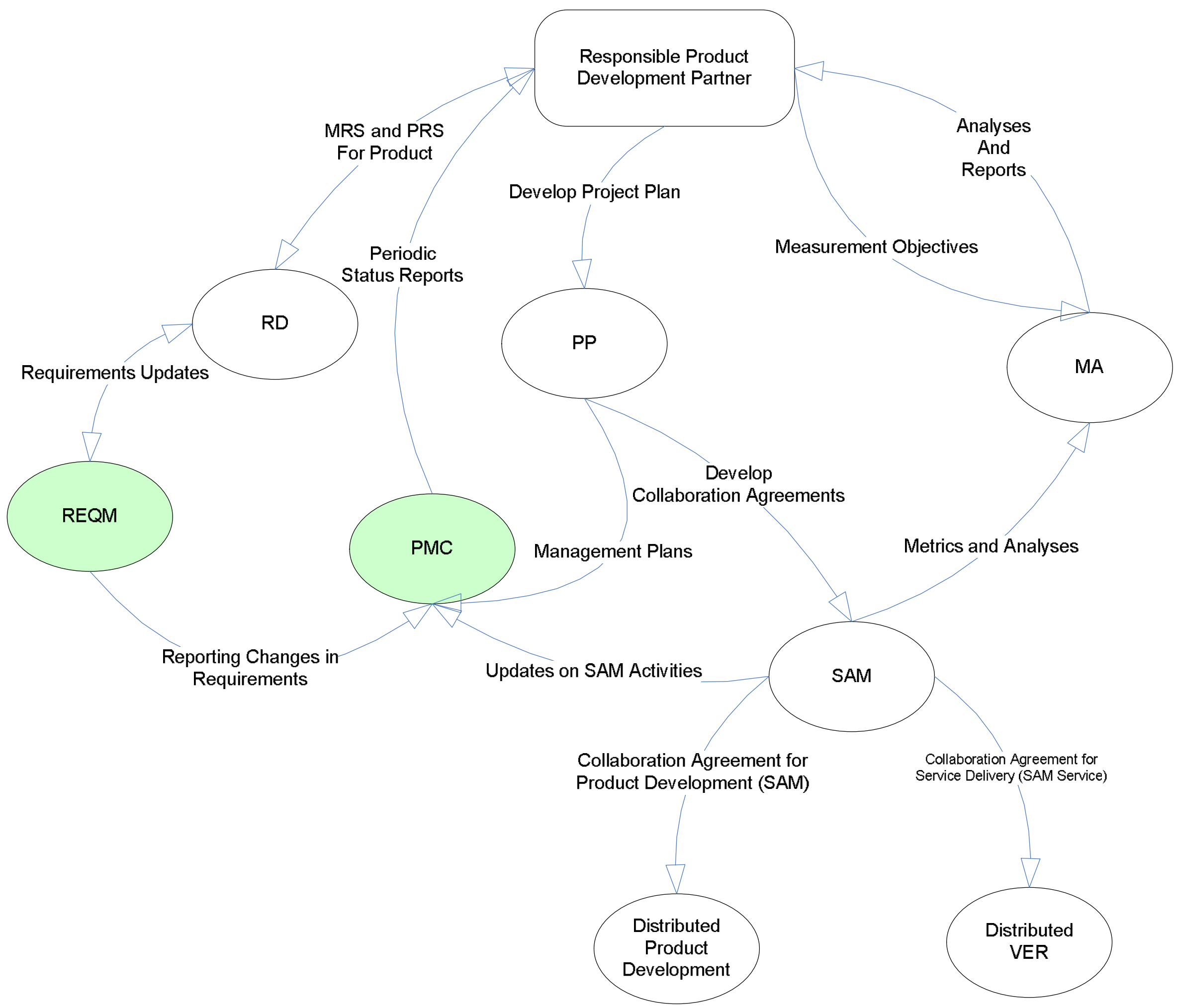
Process Area Relationships Stage 3



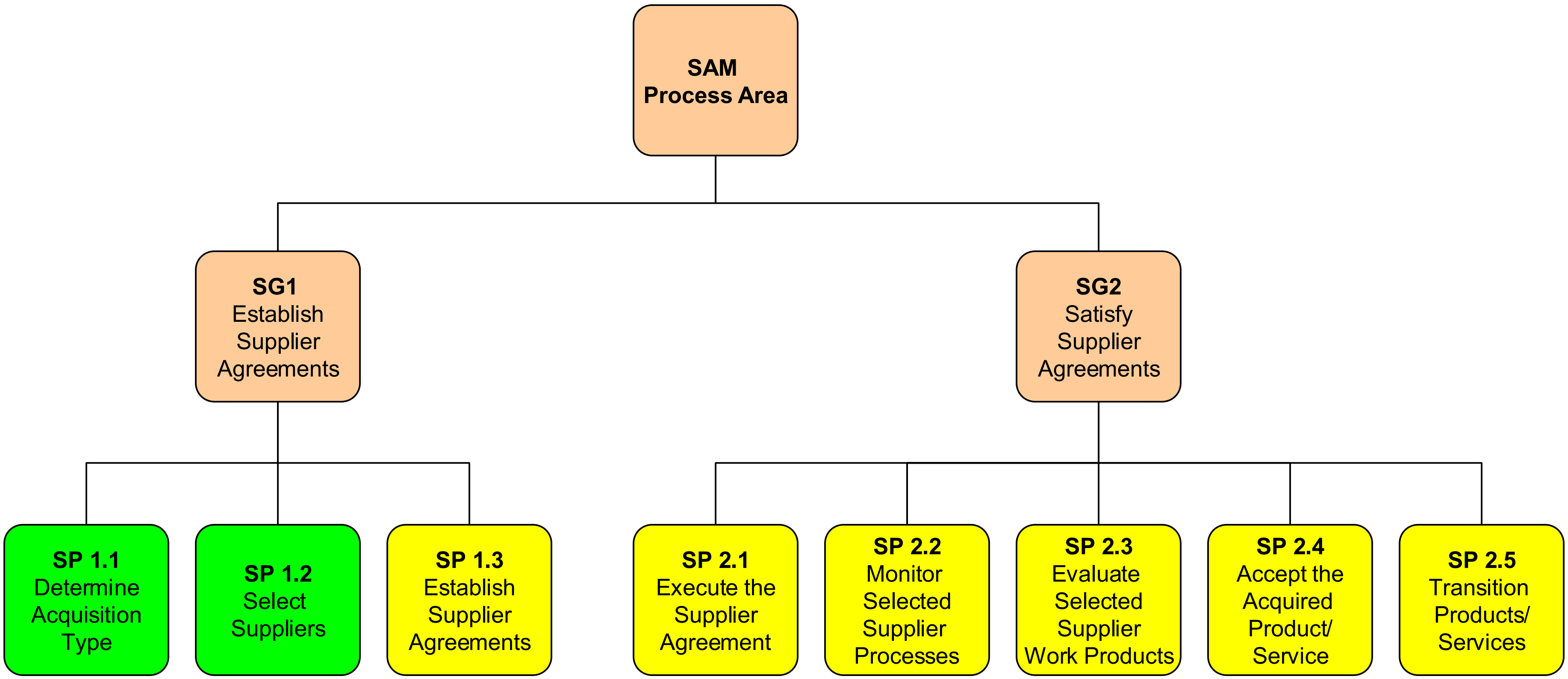
ss Area Relationships Stage 4



ss Area Relationships
Stage 5



SAM Specific Goals/Practices - Appraisal Results



Note: No procedures for collaboration/sub-contracting of products/services only for COTS

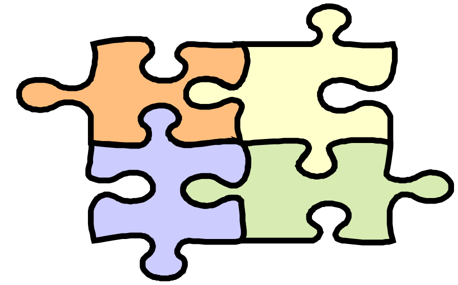
SAM Process Area -1-

- SG1 - Establish Supplier Agreements
  - SP 1.1 - Determine Acquisition Type
    - Acquisitions may be COTS from third-party vendors, components developed by internal or external partner, or services delivered by internal or external partner
  - SP 1.2 - Select Suppliers
    - Establish criteria for selection of partners and also list of preferred suppliers/collaboration partners
  - SP 1.3 - Establish Agreements with Suppliers
    - Establish formal agreements with suppliers and collaboration partners (service agreements, product development agreements, license agreements, etc)
    - For internal partners the formal Supplier Agreement is a Collaboration Plan, which is part of the Project Plan

SAM Process Area -2-

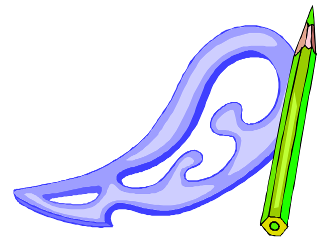
- SG2 - Satisfy Supplier Agreements
  - SP 2.1 - Execute the Supplier Agreement
    - For internal partners the formal Supplier Agreement is a Collaboration Plan, which is part of the Project Plan
  - SP 2.2 - Monitor Selected Supplier process
    - For internal collaboration partners use internal release process
  - SP 2.3 - Evaluate Selected Supplier Work Products
    - This applies to internal developed components or services such as testing
  - SP 2.4 - Accept the Acquired Product
    - Services such as testing are also considered
  - SP 2.5 - Transition Products
    - Services such as testing are also considered

Verification as a Service Activity - SAM^{SVC}



- System and Integration Testing considered as a Service Delivery activity in the organization
- SAM ^{SVC} not Implemented in the past in the organization
  - Service Delivery
  - Capacity and Availability Management
  - Problem Management
  - Incident and Request Management

Sample Collaboration Agreement Templates

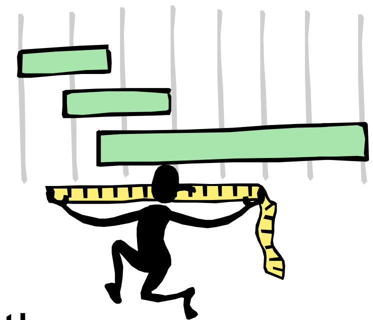


- Sample Templates derived from SAM PA to be distributed and discussed with attendees:
  - Collaboration Agreement for Remote Product Development
  - Collaboration Agreement Template for Remote Service Delivery (Software Testing/Verification)

MA Process Area – 1 –

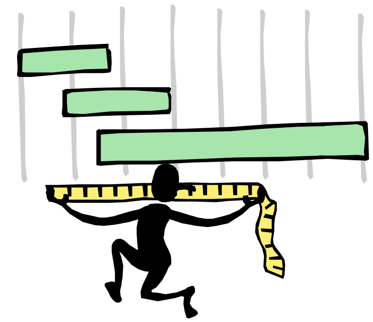
- Measurement Objective
  - To improve “partner’s” satisfaction
- Measures
  - Number of “partner’s” complaints
    - Party or stakeholder involved in collaboration can enter a complaint after a week of not having received response to an issue
  - Level of severity of “partner’s” complaints
    - Low - first entry associated with a complaint
    - Medium - second entry associated with a previous complaint
    - High - more than two entries associated with a previous complaint

MA Process Area – 2 –



- Data Collection and Storage
  - A partner/stakeholder enters a written complaint in the Complaint Spreadsheet available in the Project Common repository
  - The Complaint Spreadsheet has several sections each regarding the identified type of collaboration
  - The complaints are reviewed weekly at the Senior Management meetings
  - Each manager is responsible to ensure any complaints are properly addressed
  - Complaint Spreadsheet is maintained by Director of Development under CM

MA Process Area – 3 –

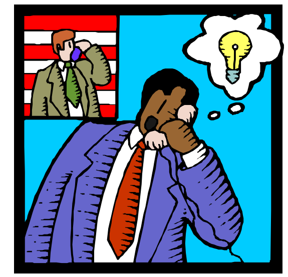


- Analysis of Measurement Data
  - Histogram showing number of complaints clustered by severity level are developed by Director of Development Solutions

MA Process Area – 4 –

- Reporting of Measurement Data
  - Histogram charts are presented at the end of each month and discussed at the Senior Management Meeting
  - Any corrective actions are tracked to completion by Director of Development Solutions

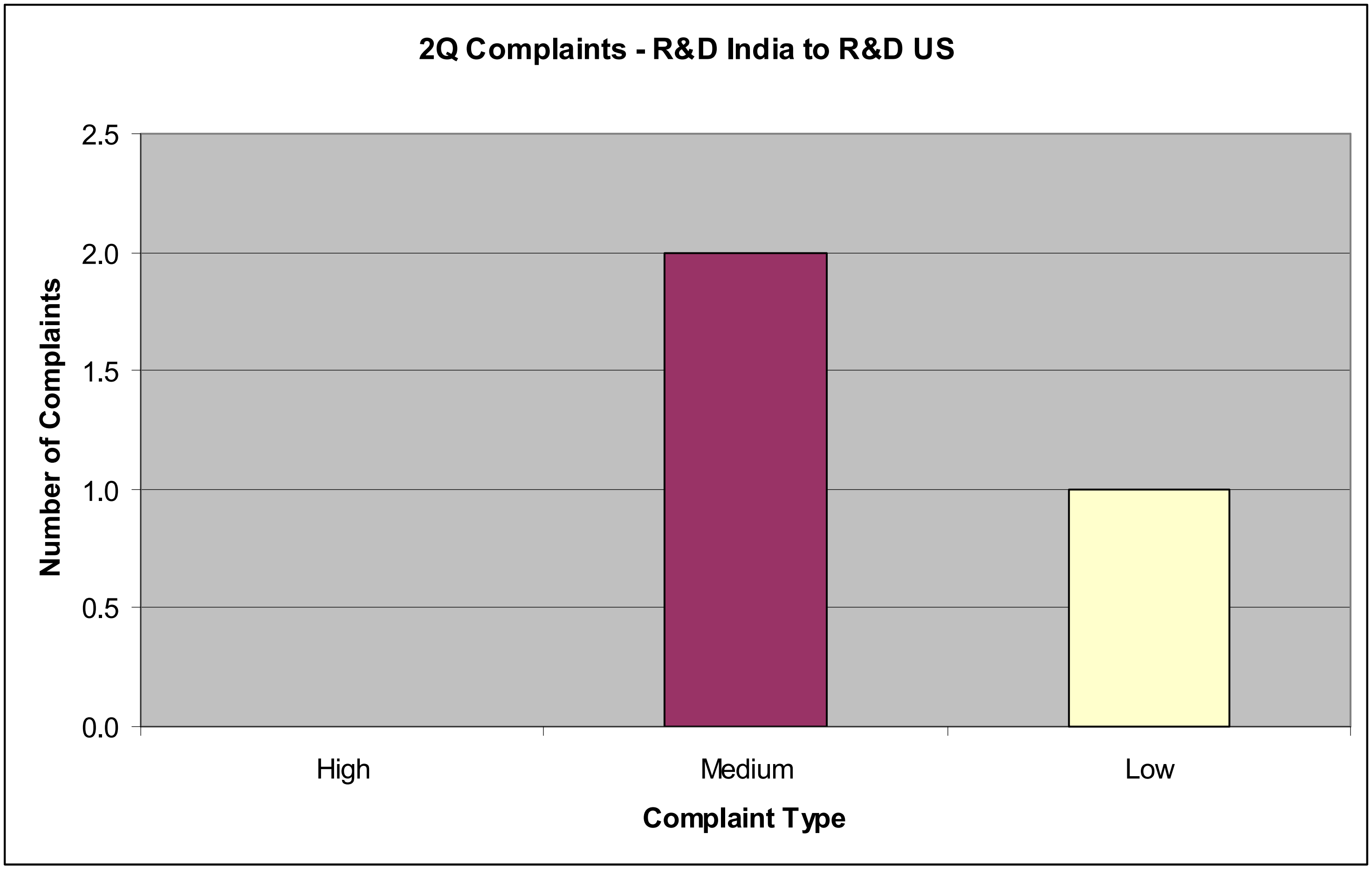
Discussion on Measurement and Analysis



Sample of Complaints Sheet 2Q of 2006

Complaint #	Severity Level	Description	Requestor Party	Requested Party	Date Created	Date Expected Resolution	Comments	Date Resolved	Date Second Entry	Date Second Entry
1	L	More detailed description of Requirement DS 0012 and no response from Development group in US	R&D India	R&D US	6-Jul-06	13-Jul-06	Details were obtained from Product Manager on 12-Jul-06-2006	12-Jul-06	-	-
2	H	Provide details about Performance Requirements and no response	Test Group India	Product Mgmt	6-Jul-06	13-Jul-06	Request passed by Director to Product Manager but no response as of 13-Jul-06.Second request by Director to Product Manager on 20-Jul-06 and no answer.	26-Jul-06	13-Jul-06	20-Jul-06
3	M	Review of general architecture document for Dashboard module without any response	R&D India	R&D US	12-Jul-06	19-Jul-06	Due to lack of time Dashboard Architecture Document was not reviewed until July 28 of 2006	28-Jul-06	19-Jul-06	-
4	M	Give presentation on new requirements on MRD without any response	R&D India	Product Mgmt	13-Jul-06	20-Jul-06	Director remindeded Product Manager to give presentation to R&D Group in India. Product Manager responded on July 21 of 2006.	26-Jul-06	20-Jul-06	-
5	L	Provide feedback on Test Plan and no feedback or notice received yet	Test Group India	R&D US	20-Jul-06	27-Jul-06	R&D group will review test Plan	25-Jul-06		
6										
7										
8										
9										
10										
11										

Sample Histogram of Complaints



Conclusions 1

- Geographically dispersed teams at SAS:
  - Product Development
  - System/Integration Testing
- System /Integration Testing viewed as Service
- With a low number of distributed projects, an informal method to collaborate was sufficient
- SAM CMMI PA needed as number of projects increased
- The practices of the SAM CMMI process area are successfully being used to manage both remote product development and service delivery

Conclusions 2

- Including the CMMI MA PA helps monitoring effectiveness of process
- Essential to build a lean process
- Focusing on the “most painful” areas was important for buy-in
- Use of SAM process reduced level of frustration in remote “sister” organizations
- Resistance on process came from “responsible” partner
- Use of templates facilitated implementation of SAM process
- Metric was identified by members of the development and testing organizations

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Automated Project Portfolio Management

Pothiraj Selvaraj

Global Computer Enterprises

November 15, 2007

Agenda

- Background
- Challenges
- Solution: Automated Management Systems
- Automated System Toolset
  - Project Planning and Scheduling
  - Technical Performance Management
  - Earned Value Management
  - Risk Management
  - Resource Management
  - Defect management

Background

- Global Computer Enterprises (GCE)
  - Systems Integration Organization
  - Federal Government Contractor
  - CMMI
    - Level 3 Certified Organization
    - Pursuing Maturity Level 4
- Projects Managed
  - Various Government Agencies
    - General Services Administration (GSA)
    - Department of Defense (DOD)
    - United States Coast Guard (USCG)
    - Transportation Security Administration (TSA)
    - Domestic Nuclear Detection Office Organization (DNDO)
    - United States Secret Service (USSS)
  - Firm-Fixed-Price Contracts
  - Project portfolio for each Agency or program within the Agency
  - Delivering Earned Value Management for all projects

Project Portfolio Management

- Project Portfolio Management (PPM) is a management approach characterized by treating related projects as part of an overall project investment portfolio
- PPM establishes a set of values, techniques and technologies that enable visibility, standardization, measurement and process improvement across all projects

PPM	Software Development & Integration
Project Portfolio	Project / Product Release
Project Investment	Project / Deliverable

PPM Challenges

Management Process	Challenges
Project Portfolio Management	Repeatable, integrated execution of all the management processes
Project Planning and Scheduling	Work, task breakdown across overlapping projects and shared resources Keeping track of constant schedule changes
Technical Performance Management	Micro level work assignment and tracking is time consuming Status checking involves intensive floor management
Earned Value Management	Collecting EVM data is labor and time intensive Involves perusing different documents such as project plans, status reports spread across documents and excel sheets
Risk Management	Tracking cost and schedule performance while taking risks into consideration is an added complexity
Resource Management	Resource utilization to obtain real-time project costs and resource pipeline Management
Defect Management	Integrated defect detection and resolution of defects in-place during the course of the projects
Business Intelligence	Generating status reports, obtaining measures and quantitative information for a collection of projects is a tedious manual process

Solution: Automated Management Systems

Management Process	Solution
Project Portfolio Management	Automated System to implement and support these management processes
Project Planning and Scheduling	Planning with EVM emphasis in mind Predefined and customizable Work Breakdown Structure and Work Distribution Structure in the system
Technical Performance Management	Robust Management of tasks Task management and workflow to transition tasks Task Inbox for each project team member Real-time status report on overall project progress
Earned Value Management	EVM data obtained from the collective repository of projects, tasks, work-items and activities Financial Controls Early Warning mechanisms
Risk Management	Integrated Risk tracking and Risk life cycle management
Resource Management	Timesheet functionality integrated with task logging against the work Breakdown
Defect Management	Defect collection, tracking and integrated defect resolution task management
Business Intelligence	Obtained from the collective repository of project management data E.g. generate real-time EVM reports, productivity measures

Automated System Toolset

Selection Criteria

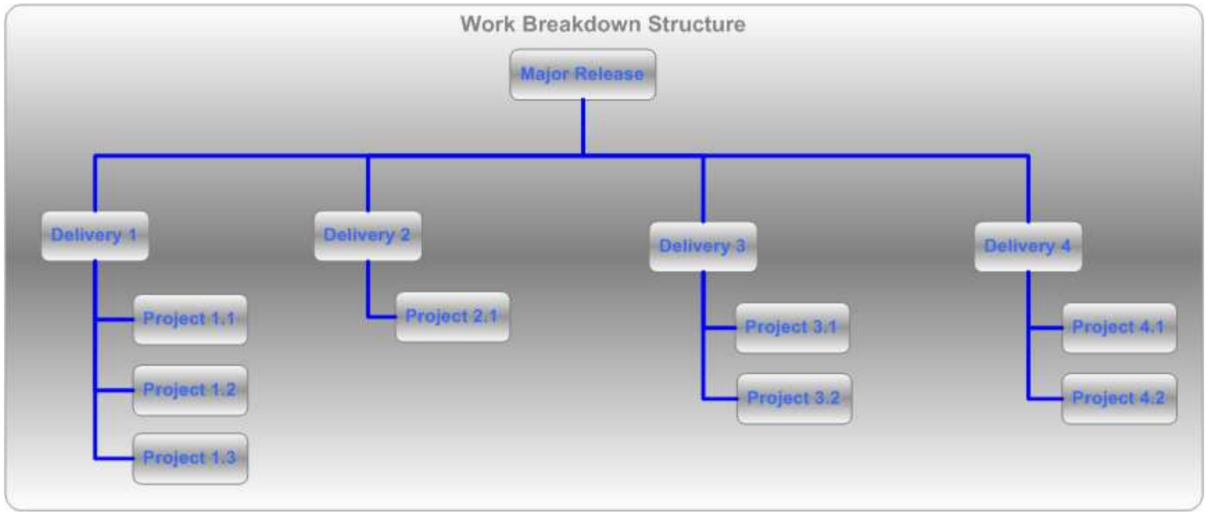
- Automated Processes
- Open Source Systems
- Integrated to manage technical, schedule, and cost performance
- Scalable, customizable and extensible

System	Tool
Schedule Management	Dotproject
Task, Cost and Timesheet Management	Dotproject
EVM Data Repository	MySQL Database
EVM Reports	Informatica
Early Warning System	Php extensions
Alerts	Postfix
Defect Management	Dotproject, JIRA

GCE

Project Planning and Scheduling

- Project plans are developed with an emphasis on EVM
- Work Breakdown structure
  - Based on PPM
  - Adopt iterative development model
  - Agile practices
  - Granularity: Estimate atomic task assignments at hourly level of detail
- Work Distribution structure
  - SDLC based
    - Distribution across SDLC phases
  - Role based
    - Resource assignment by segregation of duties
  - Dependencies recorded and tracked



Technical Performance Management

- Online Work Management System (WMS)
  - Web-based project management tool
  - Robust portfolio management of projects and micro tasks for all organization
  - Monitor and track all projects and tasks
- Real-time Tracking
  - Project actual % completion available real-time
    - Independent assessment
    - Objective evidences
  - Ability to monitor project progress in real time
  - Slice and dice data across releases, deliveries and projects
- Task Life Cycle Management
  - Online task creation, assignment and completion
  - Task status reporting of complete, pending tasks

Technical Performance: Portfolio Status

Progress	Project Name	Start Date	End Date	Owner	Status
60.0%	[illegible]	09/13/2007	09/21/2007	[illegible]	In Progress
75.0%	[illegible]	07/09/2007	09/30/2007	[illegible]	In Progress
100.0%	ZYKKJDLFJLSDTUERWERERQW	09/28/2007	10/01/2007	[illegible]	In Progress
96.9%	[illegible]	09/10/2007	10/05/2007	[illegible]	In Progress
100.0%	[illegible]	09/29/2007	10/05/2007	[illegible]	In Progress

High Level Portfolio Status view

Technical Performance: Project Status

	Pin	New Log	Work	Percent Weightage	External Assesment	P	Task Name	Line Of Business	SDLC Phase	Milestone in SDLC Phase	Technology Stack
		Log	100%	0%	0%		***Service Pack*** [redacted] (13)	Operation			
		Log	100%	0%	0%		[redacted] ***Discrepancy in Warning Message format causing issues*** (4)	Operation			
		Log	100%	0%	0%		Technical Resolution	Maintenance	Technical Resolution	Technical Draft Resolution	Business Services
		Log	100%	0%	0%		Development	Maintenance	Development	Business Logic	Business Services
		Log	100%	0%	0%		Functional Certification	Maintenance	Development	Functional Certification	Business Services
		Log	100%	0%	0%		Technical Certification	Maintenance	Development	Technical Certification	Business Services

Project Gantt view

Earned Value Management

- EVM data
  - Real-time data from WMS
  - Estimates
  - Project percent completion
  - Funds Burned
  - Schedule Burned
- Funding Variance controls
  - Automatic alerts when funding variances exceed threshold
- Uniform Spending
  - Permit task performance and work logging only within the budgeted weekly burn rate
- Task and Project Period of performance
  - permits task performance and logging only with the project period of performance of task or project
- Real-time Reports
  - Visibility into SPI and CPI
  - Accurate and timely data
  - Effective decision making

Real-time EVM Report

Project Name	Period Of Performance (in Days)	Funding Level	Scheduled Days Left	Total Funding Left	Percentage Schedule Burned	Percent Completed	Schedule Variance	Percent Funding Burned	Funding Variance	Projected Earning Per Burn Rate	Actual Earning
Project 1	91	$356.25	52	$261.75	42.86%	30.77%	-12.09%	26.53%	4.24%	$94.50	$109.62
Project 2	91	$14,207.74	52	$10,787.24	42.86%	38.46%	-4.40%	24.07%	14.39%	$3,420.50	$5,464.30
Project 3	91	$494.00	52	$458.00	42.86%	33.00%	-9.86%	7.29%	25.71%	$36.00	$163.02
Project 4	91	$15,547.12	52	$13,459.12	42.86%	25.51%	-17.35%	13.43%	12.08%	$2,088.00	$3,966.07
Project 5	91	$4,984.04	52	$3,724.04	42.86%	38.46%	-4.40%	25.28%	13.18%	$1,260.00	$1,916.86
Project 6	91	$1,004.81	52	$853.81	42.86%	38.46%	-4.40%	15.03%	23.43%	$151.00	$386.45
Project 7	91	$1,534.62	52	$702.12	42.86%	46.15%	3.29%	54.25%	-8.10%	$832.50	$708.23
Project 8	91	$2,280.00	52	$1,272.00	42.86%	46.15%	3.29%	44.21%	1.94%	$1,008.00	$1,052.22

Real-time EVM Report

Real-time EVM: Early Warning Mechanisms

- Calculate cost and schedule variances
  - Automated check on each project
  - Calculated from integrated, real-time WMS system
- Identify work variance thresholds
  - Variances exceed acceptable tolerances
    - Schedule burned
    - Funding burned
- Automated alerts when variance thresholds are exceeded
  - Program Management
  - Execution Teams
- Risk Management
  - Identify cost and schedule overrun risks at an early stage
  - Respond more quickly with mitigation strategies

Risk Management

- Risk Identification
  - Risk details such as probability and impact of risk
- Risk Analysis
  - Association with a task (Origin of risk), actual impact (number of days of effort, total dollars for equipment etc.)
- Risk Mitigation
  - Planning changes
  - Risk mitigation tasks created and assigned
- Risk Monitoring and Control
  - Resolution of the risk
  - Implement the tasks for containing the risk
  - Tracking and communication of risk mitigation tasks
  - Budget and cost automatically updated

Resource Management

- Utilization Reports
  - Overutilization
  - Underutilization
- Cumulative timesheet entries from task logs
  - Record and report time worked on a project
- Identify trends
  - Workload
  - Resource management

Users: All

Projects: All

Users	Week 40	Week 41	Week 42	Week 43	Week 44	Week 45	Week 46	Week 47	Week 48	Week 49	Week 50	Week 51	Week 52
S/W Engineer	22.79	22.79	22.79	22.79	22.79	22.79	22.79	22.79	22.79	41.21	41.21	22.42	22.42
S/W Engineer	40	40	40	40	40	40	40	40	40	40	40	40	40
S/W Engineer	40	40	40	40	40	40	40	40	40	40	40	40	40
S/W Engineer	30.86	30.86	30.86	30.86	30.86	30.86	30.86	30.86	17.33	17.33	17.33	14.73	14.73
S/W Engineer	26.71	33.17	33.17	33.17	33.17	33.17	33.17	33.17	25.32	25.32	25.32	25.32	25.32
S/W Engineer	39.57	39.57	39.57	39.57	39.57	39.57	39.57	39.57	39.57	39.57	39.57	39.57	39.57

Real-time Resource Allocations view

Resource Management Contd.

- Timesheet is integrated within the WMS
  - Report by hierarchical work breakdown structure
  - Report by individual user, project, division

Project/UserName	Sep 23-29	Sep 30-Oct 06	Oct 07-13
Release 1	1457.08	1481.27	1385.5
Delivery 2	1457.08	1481.27	1385.5
Project 1	91.5	84	106.8
Engineer 1	21	0	32
Engineer 2	0	0	0
Manager 1	27	40	40
Architect 1	0	0	12
QA 1	23.5	20	22.8
QA 2	20	24	0
Project 2	74	77	59.5
Manager 2	32	33	28.5
Engineer 3	17	36	21
Engineer 4	25	8	10
Project 3	78.5	91.5	76
CM 1	27	28.5	40
System Admin 2	15	32	30
DBA 3	36.5	31	6
Project 4	16	4	20

Hierarchical Task Hour Report

Resource Management Contd.

Weekly Time Card

Saturday 10/06/2007 through Friday 10/12/2007 test user (testuser) [My Time Card]

Task Name	Task Log Type	Log Entry	Hours
Saturday 10/06/2007			
		Total Hours	0
Sunday 10/07/2007			
		Total Hours	0
Monday 10/08/2007			
		Total Hours	0
Tuesday 10/09/2007			
		Total Hours	0
Wednesday 10/10/2007			
		Total Hours	0
Thursday 10/11/2007			
		Total Hours	0
Friday 10/12/2007			
		Total Hours	0

For the week of Saturday 10/06/2007 through Friday 10/12/2007

Total Hours	0
Status	

Weekly Timesheet Report

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Defect Management

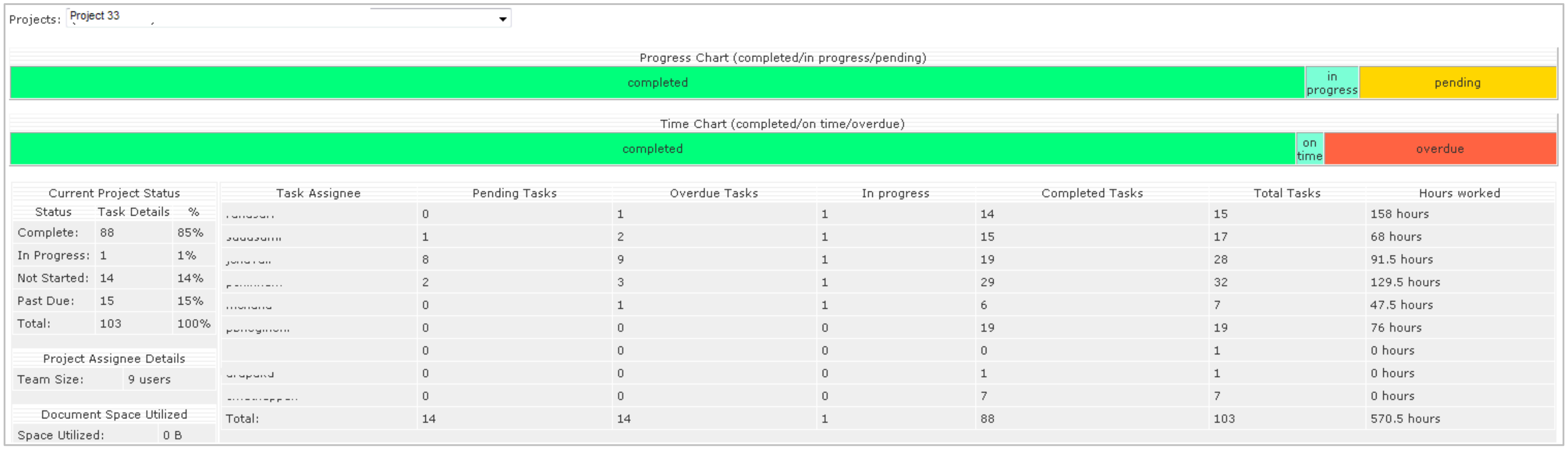
- Integrated with the projects and tasks in the WMS system
- Defect Tracking
  - Originating task
  - SPR number created in JIRA
  - Task is executed through phases of SDLC
- Task Performance Measurement
  - Software defects
  - Document issues
  - Meeting attendance
- Reports
  - Defect density
  - Defects per KSLOC
  - Defect statistics by origin, project, resource

Business Intelligence

- Task Management
  - Task tracking reports
  - Task status reporting of complete, pending tasks
- Risk Management Measures
- Defect Measures
- Resource Utilization Measures

GCE

Business Intelligence Contd.


Projects: Project 33

Progress Chart (completed/in progress/pending)

completed | in progress | pending

Time Chart (completed/on time/overdue)

completed | on time | overdue

Current Project Status		
Status	Task Details	%
Complete:	88	85%
In Progress:	1	1%
Not Started:	14	14%
Past Due:	15	15%
Total:	103	100%

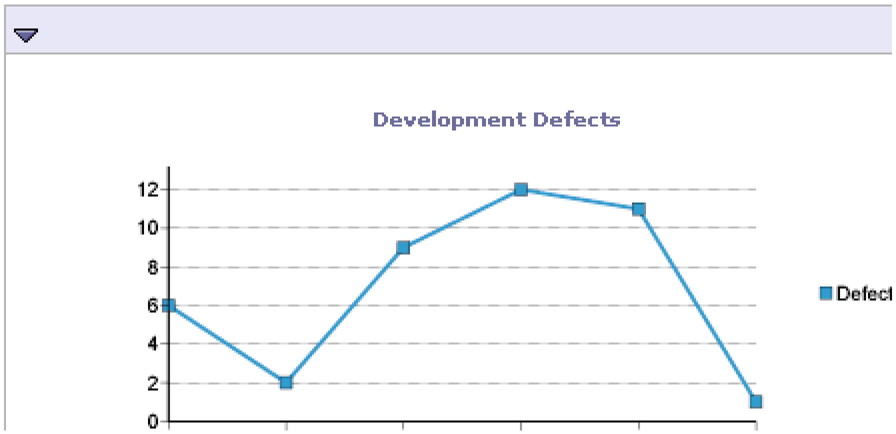
Project Assignee Details	
Team Size:	9 users

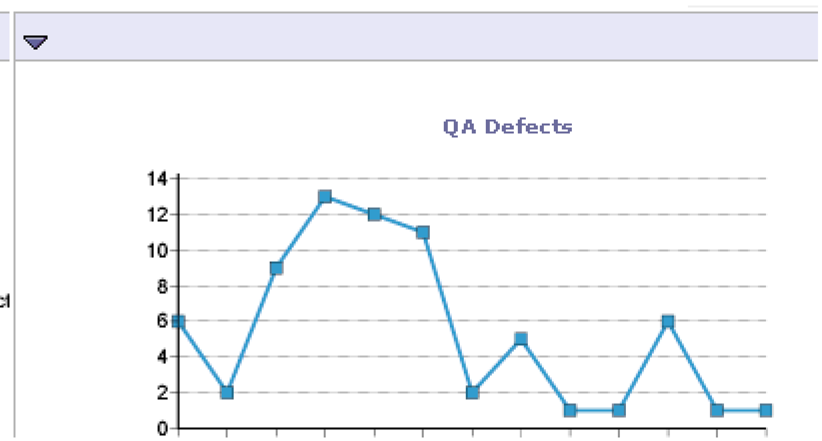
Document Space Utilized	
Space Utilized:	0 B

Task Assignee	Pending Tasks	Overdue Tasks	In progress	Completed Tasks	Total Tasks	Hours worked
[illegible]	0	1	1	14	15	158 hours
[illegible]	1	2	1	15	17	68 hours
[illegible]	8	9	1	19	28	91.5 hours
[illegible]	2	3	1	29	32	129.5 hours
[illegible]	0	1	1	6	7	47.5 hours
[illegible]	0	0	0	19	19	76 hours
	0	0	0	0	1	0 hours
[illegible]	0	0	0	1	1	0 hours
[illegible]	0	0	0	7	7	0 hours
Total:	14	14	1	88	103	570.5 hours

Project Statistics Dashboard

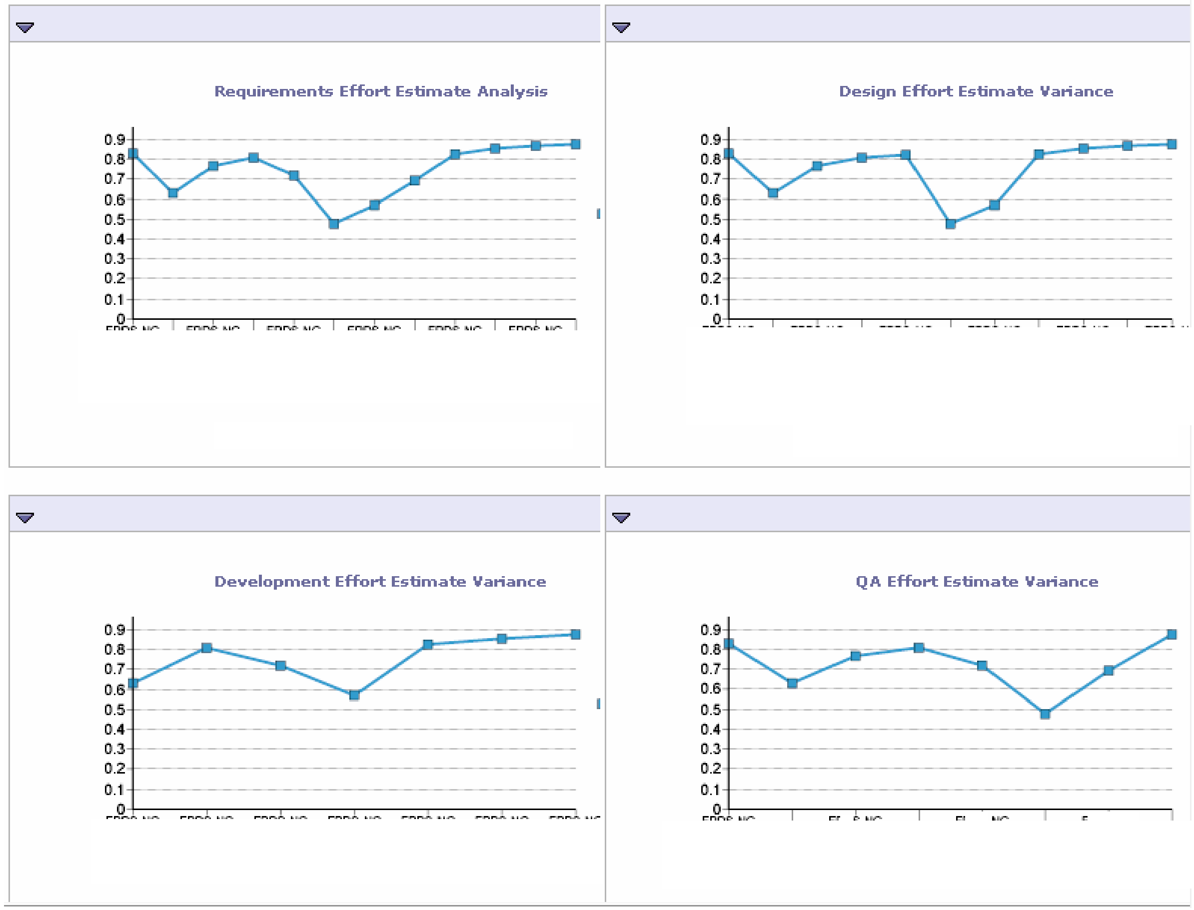
Business Intelligence Contd.





Project Defects Dashboard

Business Intelligence Contd.



Project Effort Estimate Variance Dashboard

Tying it back to CMMI

PPM Processes	CMMI Process Areas	Maturity Level
Project Portfolio Management	Integrated Project Management (IPM)	3
Project Planning and Scheduling	Project Planning (PP)	2
Technical Performance Management	Project Monitoring and Control (PMC)	2
Earned Value Management	Integrated Project Management (IPM)	3
	Project Monitoring and Control (PMC)	2
Risk Management	Risk Management (RSKM)	3
	Validation (VAL)	3
Defect management	Verification (VER)	3
Resource Management	Project Planning (PP)	2
	Measurement and Analysis (M&A)	3
	Quantitative Project Management	4
Business Intelligence Reports and Dashboards	Organizational Process Performance (OPP)	4

GCE

References

- Normative References
  - GCE Guiding Management Principles
  - OMB Circular A11, Part 7
    - http://www.whitehouse.gov/omb/circulars/a11/current_year/s300.pdf
  - American National Standards Institute (ANSI)/Electronic Industries Alliance (EIA) Standard –748–1998 Earned Value Management Systems, approved May 19, 1998. It was reaffirmed on August 28, 2002.
- Informative References
  - PMI College of Performance Management
    - http://www.pmi-cpm.org/pages/home/index.html
  - Dotproject
    - http://www.dotproject.net/
  - Quantitative Methods in Project Management
    - John C Goodpasture. (2004)
  - Agile EVM – Earned Value Management The Agile Way
    - Tamara Suleiman
  - CMMI: Guidelines for Process Integration and Product Improvement, Second Edition
    - Mary Beth Chrissis, Mike Konrad, and Sandy Shrum

Summary

- Automation leading to PPM approach easily implemented by a smaller organization
- Solution for common PPM challenges across all organizations
- Automated PPM provided the foundation
  - Easier CMMI adoption
  - Level 3 Appraisal
- Intention to approach ML4 activities in a similar fashion
- Thoughts
  - Real-time introspective management vs. retrospective management
  - Emphasis on forecasting for tomorrow rather than project instances

Thank you

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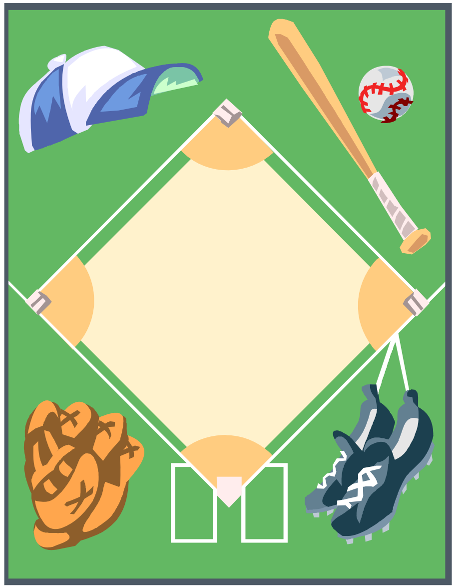
CMMI, Configuration Management, and Baseball How to Score

Julie Schmarje
Raytheon, Space and Airborne Systems (SAS)
November 15, 2007

Topics

- CMMI and Baseline Management
- CM and Baseline Management
- How to Score
- Summary



Purpose

- **Describe the CM Baseline Management process and how it relates to:**
  - CMMI
  - Program Execution
  - Baseball

- **Describe the consequences of poor Baseline Management performance**

Common Terms

- **The following terms are used in a generic manner:**
  - Baseline: An approved work product at a specific revision/version and date. A baselined work product is one that is released and controlled by CM.
  - Configuration Baseline: A set of one or more baselined work products which represent the approved version of a predefined collection of work products.
  - Change Request (CR): A request to change a baselined work product. The CR on programs could be an PCR, EO, SCR, SPCR, STR, etc.
  - Configuration Control Board (CCB): The board that reviews and dispositions CRs against baselined work products. The board that performs this function could be called any one of a number of names – ERB, CRB, SCCB, CCB, PRB, etc.

What is Configuration Management?

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- **Configuration Management (CM) is a process that establishes and maintains the integrity of work products.**
- **Consists of five functional areas:**
  - **Planning** – How will CM be performed on a project?
  - **Configuration Identification** – How will configuration items be established and work products identified and what are their relationships within a product structure?
  - **Configuration Control** – How will the work products and changes to the work products be controlled?
  - **Status Accounting** – How will the status of the CM processes and program work products be managed and communicated?
  - **Reviews & Audits** – How will the establishment and use of the CM processes be verified? How will the control of work products be verified?

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What is Baseline Management? (1)

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What is a baseline? What does it mean to "baseline" something? →	Defining Baselines
What's in a baseline? →	Identifying Baselines
How do I change what's in a baseline? →	Controlling Baselines
What changed since yesterday? last year? last baseline? →	Status Accounting of Baselines
Why should I believe the CM system? →	Reviews & Audits of Baselines
What baselines are needed on my project? →	Planning Baselines

What is a baseline & why do we have to manage it?

CMMI®

What is a Baseline? (2)

- **Individual work products**
  - Baseline “the verb”
    - For individual work products, the act of releasing a work product into the configuration management system.
  - Baseline “the noun”
    - The version or versions of the work product in the configuration management system.
- **Configuration Baseline**
  - Common Configuration Baselines include the Functional, Allocated, and Product Baselines.

How are Baselines Identified?

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- **Individual work products have identifiers**
  - drawing number
  - document ID
  - code file version number
- **...and revision or version indicators**
  - revision letter (e.g., Rev. A)
  - version number, e.g., Version 1.2)
- **Configuration Baselines also have an identifier and a revision/version indicator**
  - Facilitates capture of different versions or snapshots of the collection as the work products, which comprise the collection, change
  - The CM information system should provide the status of a Configuration Baseline at selected points
    - by date
    - software build number
    - hardware serial number

Individual/Configuration Baselines must be identified to be effectively managed.

How are Baselines Controlled?

- **An activity or event triggers a work product release**
  - Preliminary Design Review – Requirements
  - Critical Design Review - Design
- **For Initial Baseline:**
  - The baseline is audited to defined criteria for the type of work product
  - The configuration records and references are created in the CM system
  - The baseline is released in the CM System
  - The Configuration Baseline is established as identified in the CM Plan
- **For Changing Baselines:**
  - Evolving baselines are maintained in the CM System as the CCB authorizes changes to be incorporated into new versions of work products and Configuration Baselines.

Baselines are established and evolve in the CM System

CMMI and Baseline Management

- **In a CMMI-compliant CM process, baselines are**
  - Created (CM SP 1.3)
    - Authorized by an approval board (e.g., CCB)
    - Using controlled items in the CM system
    - Identified in the CM System, including the current configuration baselines
  - Managed
    - Using specific baseline processes (CM GP 2.2, 3.1)
    - Within an established CM System (CM SP 1.2)
    - Controlled changes to baselines (CM SP 2.2)
  - Verified
    - Audited baselines as they're established (CM SP 3.2)
    - Audited controlled baselines using CM records (CM SP 3.1, GP 2.9)

Good CM processes include Baseline Management

Baseline Management and Baseball (1)

- **There are parallels between good Baseline Management and winning at baseball**
  - With a more mature understanding of processes and mature products (work products/players) it is easier to be successful (stable baselines/home runs)
  - Both have recognized industry standards
  - Team members must work together to be successful
  - New technologies/players can go through a try out period to identify strengths and areas to develop. For companies, this evolving set of work products are a company asset and should be baselined and managed.
  - Good management is essential to being successful
    - Day to day
    - Long term

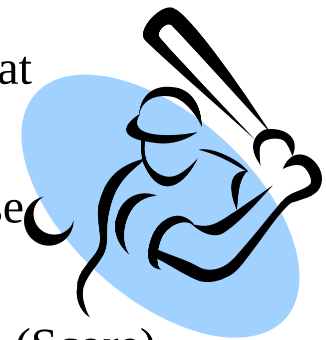
Baseline Management and Baseball (2)

- **The following topics illustrate the similarities between the Baseline Management process and Baseball:**
  - Individual Baseline
  - Baseline Verification
  - Configuration Baseline
  - Product Baseline
  - Opponents
  - Results of Winning

Individual Baseline

- **Configuration Management**
  - Identify Work Product
  - Create Work Product
  - Successful Peer Review
  - Successful CCB Review
  - Release (Baselined) Work Product

- **Baseball**
  - Identified player at bat
  - Player at First Base
  - Player at Second Base
  - Player at Third Base
  - Player at Home Plate (Score)



- **Comments**
  - Unless the Work Product is created (player able to advance to First Base), the process cannot begin
  - Unless its Peer and CCB reviewed and approved it can't advance to release
  - There are legitimate ways to advance when the ball isn't in play (stealing); however, not following the process creates problems (you're out!)
  - Status Accounting data about Individual Baselines are similar to a player's statistics – how it evolved and performed from inning to inning.

"Home Run" occurs when all steps are conducted smoothly

CMMI®

Baseline Verification

- **Configuration Management**
  - Baseline Audits
  - Process and Product Audits

- **Baseball**
  - Umpires

- **Comments**
  - Like baseball, Work Product Baselines are verified as they are established.
    - Audits are performed on work products prior to baseline (Home Plate Umpire)
    - Audits are performed on performance to the Baseline Management process (all Umpires looking to see if players are following the process)
  - Work Product and Configuration Baselines are audited to see if they are correctly controlled (Umpires and League)

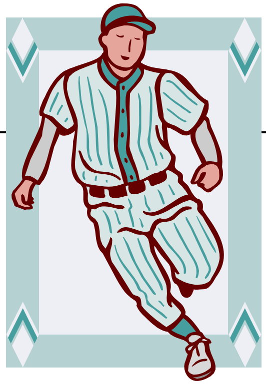
Integrity of the process and products are verified

Configuration Baseline

- **Configuration Management**
  - Identify Configuration Baselines
  - Create Configuration Baseline
  - Change Configuration Baseline

- **Baseball**
  - Innings: identified in Baseball Rules
  - First Inning
  - …. Ninth Inning

- **Comments**
  - As the Configuration Baseline evolves, the status accounting data is maintained (similar to the evolving score in baseball).
  - The score at the end of each inning is a snapshot in time



As the game progresses the score (Conf Baseline) evolves

Product Baseline

- **Configuration Management**
  - Identify Product Baseline/TDP
  - Control Product Baseline/TDP
  - Deliver Product Baseline/TDP

- **Baseball**
  - Identify schedule for a game
  - Conduct game
  - Complete 9 innings

- **Comments**
  - The game (components of Product Baseline/TDP) is identified ahead of time
  - The game is conducted and statistics kept about performance (Baseline Management and Status Accounting)
  - The baselined product is delivered (final score). Winning depends on how successful the teams were in scoring/developing and controlling good work products.
  - Errors have consequences, some impact the game more than others (the game could be prolonged/stretched out impacting period of performance)

As the game progresses errors can be disastrous to success

Opponents (Preventing Success)

- **Configuration Management**
  - Insufficient Configuration Mgmt
  - No Defined Process
  - Poor Planning
  - Poor Execution
  - Poor Leadership
  - Poor Team Cohesiveness
  - Lack of Maturity
  - Lack of Training
  - Lack of Sufficient Resources

- **Baseball**
  - Opposing Team
  - Owners
  - Poor Team Execution
  - Poor Team Leadership
  - Poor Team Cohesiveness
  - Lack of Player Maturity
  - Lack of Player Training

- **Comments**
  - Many factors can hinder successful delivery of the Product Baseline/TDP on a program
  - With insufficient Configuration Management, it is difficult to successfully track the evolving Configuration Baseline and deliver the Product Baseline

Results of Winning

- **Configuration Management**
  – Ability to easily provide any Work Product Baseline or Configuration Baseline
  – Repeat Customers
  – New Customers/Programs

- **Baseball**
  – Happy Owners
  – Loyal fans
  – New fans
  – Highly paid players/endorsement offers

- **Comments**
  – With successfully controlled baselines and deliveries, a company has a high probability of obtaining new programs and repeat customers.

Summary

- **Ultimately, to win a baseball game, a team must be able to successfully score points and defend against their opponents**
- **Owners drive the success or failure of both the CM processes and Baseball teams. However, in the CM processes all participants are owners of the process, whereas only one rich guy owns the ball club.**
- **To be successful at delivering the correct product to your customer**
  - A Baseline Management process must be defined and followed
  - Work Product Baselines must be identified, controlled, and managed
  - Configuration Baselines must be established and maintained
  - Product Baselines/TDPs created and delivered from the controlled Baselines

Acronyms

CCB	Configuration Control Board
CM	Configuration Management
CMMI	Capability Maturity Model Integrated
CR	Change Request
CRB	Change Review Board
EO	Engineering Order
ERB	Engineering Review Board
PCR	Program Change Request
PRB	Program Review Board
SCR	Software Change Request
SPCR	Software Problem Change Request
STR	Software Trouble Report
TDP	Technical Data Package

…es Make Perfect – How Your Engineering and Management Practices Can Help Meet the Systems Assurance Challenge

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Chair, DHS Software Assurance Forum Working Group on Processes and Practices

Past Convener, ISO/IEC JTC1/SC7 WG9, System and Software Assurance

Outline

- System Assurance Defined
- The System Assurance Problem Space
- Software As A Root Cause Problem
- The Systems Engineering Challenge
- The CMMI® and Assurance
- Bang-For-The-Buck CMMI-DEV® Process Areas
- Guidance For Systems Assurance
- Standardization In Support Of Systems Assurance

m Assurance Defined

System assurance is the level of confidence that the system functions as intended and is free of exploitable vulnerabilities, either intentionally or unintentionally designed or inserted as part of the system.

m Assurance Problem Space

- Large-scale systems and systems of systems represent a complex supply chain integrating
  - ï Proprietary and open-source software
  - ï Legacy systems
  - ï Hardware
  - ï Firmware
- These systems are sourced from multiple suppliers who employ people from around the world
- Most systems we encounter today contain software elements and most depend upon software for a good portion of their functionality
- Technologies to build reliable and secure software are inadequate
  - ï Our ability to develop software has not kept pace with hardware advances
  - ï Canðt construct complex software-intensive systems for which we can anticipate performance
- **Assurance is a full life cycle systems-level problem**

…are As A Root Cause Problem

- System risk has dramatically increased due to the simultaneous growth in software vulnerabilities and in threat opportunities
- Risk management processes inadequately address these threats and risks
- Threats presented by suppliers of software products and services are not adequately identified and analyzed
- Development and acquisition processes inadequately address software security
- There is a fundamental lack of both the scientific understanding of software risks and the capabilities to effectively diagnose and mitigate in the in a timely manner

Source: J. Jarzombek. DOD Software Assurance Initiative: Mitigating Risks Attributable to Software. DOD Software Assurance Forum, July 2004.

More Succinctly . . .

- There is a failure to assure correct, predictable, safe, secure execution of complex software in distributed environments
- Inadequate attention is given to the total life cycle issues, including impacts on life cycle cost and risk associated with the use of commercial or reused products and components

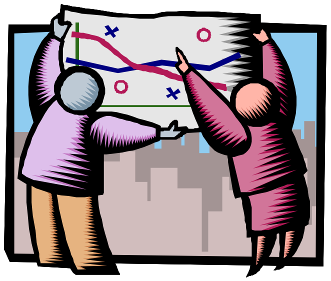
Source: G. Draper (ed.), Top Software Engineering Issues Within Department of Defense and Defense Industry. National Defense Industrial Association, Arlington, VA, August 2006.

Systems Engineering Challenge

Integrating a heterogeneous set of globally engineered and supplied proprietary, open-source, and other software; hardware; and firmware; as well as legacy systems; to create well-engineered integrated, interoperable, and extendable systems whose security, safety, and other risks are acceptable ï or at least tolerable.

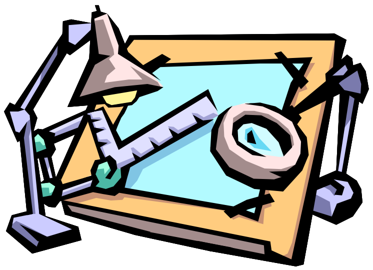
System and Software Assurance Through CMMI®-Compliant Processes

1. Understand Your Business Requirements for Assurance



5. Measure Your Results - Modify Processes as Necessary

4. Build or Refine and Execute Your Assurance Processes



2. Look to the CMMI® for Assurance-Related Process Capability Expectations

3. Look to Standards for Assurance Process Detail

MI®- DEV Assurance Shortfalls

- Inconsistent treatment of safety and security concerns
- Insufficient assurance detail in required and expected components
  - ï Specific goals
  - ï Specific practices
- Insufficient traceability to assurance source standards

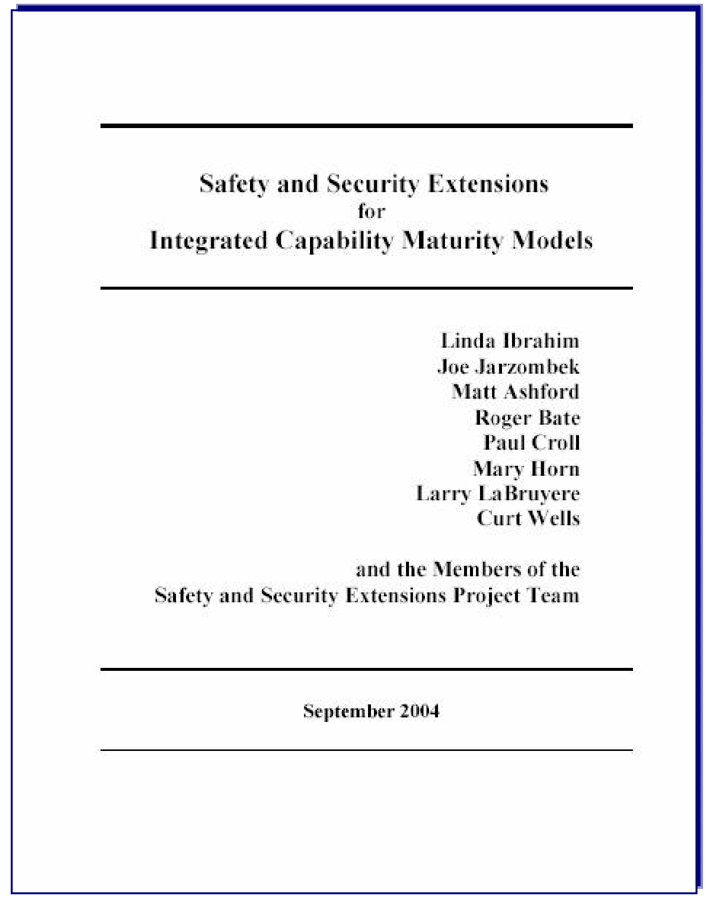
CMMI® ï DEV Process Areas and Assurance

Source: CMMI® for Development, Version 1.2, CMU/SEI-2006-TR-008, August 2006

Name	Abbr	Safety	Security
Requirements Management	REQM	√	√
Project Planning	PP	√	√
Project Monitoring and Control	PMC		√
Supplier Agreement Management	SAM		√
Measurement and Analysis	MA		√
Process and Product Quality Assurance	PPQA		
Configuration Management	CM	√	√
Requirements Development	RD	√	√
Technical Solution	TS	√	√
Product Integration	PI	√	√
Verification	VER		
Validation	VAL		
Organizational Process Focus	OPF		
Organizational Process Definition +IPPD	OPD +IPPD	√	√
Organizational Training	OT	√	√
Integrated Project Management +IPPD	IPM +IPPD	√	√
Risk Management	RSKM	√	√
Decision Analysis and Resolution	DAR	√	
Organizational Process Performance	OPP		
Quantitative Project Management	QPM		
Organizational Innovation and Deployment	OID		
Causal Analysis and Resolution	CAR	√	

…and Security Extensions for …d Capability Maturity Models ï Take 1

1. **Ensure Safety and Security Competency**
2. **Establish Qualified Work Environment**
3. **Ensure Integrity of Safety and Security Information**
4. **Monitor Operations and Report Incidents**
5. **Ensure Business Continuity**
6. **Identify Safety and Security Risks**
7. **Analyze and Prioritize Risks**
8. **Determine, Implement, and Monitor Risk Mitigation Plan**
9. **Determine Regulatory Requirements, Laws, and Standards**
10. **Develop and Deploy Safe and Secure Products and Services**
11. **Objectively Evaluate Products**
12. **Establish Safety and Security Assurance Arguments**
13. **Establish Independent Safety and Security Reporting**
14. **Establish a Safety and Security Plan**
15. **Select and Manage Suppliers, Products, and Services**
16. **Monitor and Control Activities and Products**



Safety and Security Extensions
for
Integrated Capability Maturity Models

Linda Ibrahim
Joe Jarzombek
Matt Ashford
Roger Bate
Paul Croll
Mary Horn
Larry LaBruyere
Curt Wells

and the Members of the
Safety and Security Extensions Project Team

September 2004

Source: United States Federal Aviation Administration, Safety and Security Extensions for Integrated Capability Maturity Models, September 2004 (http://www.faa.gov/about/office_org/headquarters_offices/aio/documents/media/SafetyandSecurityExt-FINAL-web.pdf)

Source Standards

Safety

- **Defence Standard 00-56**, Safety Management Requirements for Defence Systems, Ministry of Defence, United Kingdom, December 1996.
- **IEC 61508**, Functional Safety of electrical/electronic/programmable electronic safety-related systems, International Electrotechnical Commission, 1997.
- Military Standard System Safety Program Requirements, **MIL-STD-882C**, United States Department of Defense, January 1993.
- Standard Practice for System Safety, **MIL-STD-882D**, United States Department of Defense, February 2000.

Security

- **ISO/IEC 21827**, Systems Security Engineering Capability Maturity Model®, SSE-CMM®, Model Description Document, Version 3.0, June 15, 2003.
- **ISO/IEC 15408:1999**, Common Criteria for Information Technology Security Evaluation, Part 3: Security assurance requirements, Version 2.1, 1999.
- **ISO/IEC 17799:2000(E)**: Information technology ï Code of practice for information security management, International Organization for Standardization, First edition 2000-12-01.
- Risk Management Guide for Information Technology Systems, **National Institute of Standards and Technology, Special Publication 800-30, 2001**.

Source: United States Federal Aviation Administration, Safety and Security Extensions for Integrated Capability Maturity Models, September 2004 (http://www.faa.gov/about/office_org/headquarters_offices/aio/documents/media/SafetyandSecurityExt-FINAL-web.pdf)

Extensions for Integrated Capability Maturity Models ï Take 2

- Workshop on Assurance with CMMI®, August 7, 2007
  - ï Relationships between Models and Standards
  - ï Industry experiences in extending models for assurance
    - Motorolaôs Secure Software Development Model
    - Lockheed Martinôs Software Safety and Security Certification Best Practices
    - Booz Allen Hamiltonôs experience with multiple models
  - ï Community of interest feedback on security extensions to the CMMI®
- Security Model Harmonization Working Group
  - ï Harmonization of key security capability maturity models including but not limited to the SSE-CMM and the Motorola Secure Software Development Model (MSSDM)
  - ï Prototyping Assurance as a ìFocus Areaò
  - ï Assurance beginning with Security in Phase I adding Safety and Dependability in Phase II

…or-The-Buck CMMI®-DEV Project Management Process Areas

$$$ **RSKM**

- Identify, Evaluate, Categorize, and Prioritize Assurance Risks
- Develop assurance risk mitigation strategies

$$ **PP**

- Determine a technical approach for the project that supports the assurance requirements
- Determine the level of security required for tasks, work products, hardware, software, personnel, and work environment

$$ **PMC**

- Monitor significant changes in risk status
- Monitor the security environment

$$ **SAM**

- Evaluate COTS products for compliance with assurance requirements
- Evaluate the trustworthiness of the supplier

CMMI® for Development, Version 1.2, CMU/SEI-2006-TR-008, Software Engineering Institute, Carnegie Mellon University, August 2006

…or-The-Buck CMMI-DEV® Process Management Process Areas

$$ OT

- Establish and maintain training capability to address assurance-related training needs
- Provide training necessary to ensure the competency of individuals required to perform assurance-related roles effectively

…or-The-Buck CMMI-DEV® …neering Process Areas

$$$ **RD**

- Identify customer expectations for assurance
- Define product assurance attributes

$$$ **TS**

- Identify and analyze alternative solutions based on proposed product architectures that address critical product qualities
- Ensure that the detailed design adheres to applicable assurance standards and criteria

$$ **VER**

- Select verification methods based on their ability to demonstrate that the work product properly reflects the specified assurance requirements
- Establish and maintain the environment needed to support validation, including test tools and simulations

$$ **VAL**

- Select validation methods based on their ability to demonstrate that customer expectations for assurance are satisfied
- Establish and maintain the environment needed to support validation, including test tools and simulations

CMMI® for Development, Version 1.2, CMU/SEI-2006-TR-008, Software Engineering Institute, Carnegie Mellon University, August 2006

…r-The-Buck CMMI-DEV® Support Process Areas

$$$ **CM**

- Create a baseline that can be changed only through formal change control procedures
- Perform reviews to ensure that changes have not compromised the safety, security, or dependability

$$ **PPQA**

- Objectively evaluate the work products against the applicable assurance process descriptions, standards, and procedures

CMMI® for Development, Version 1.2, CMU/SEI-2006-TR-008, Software Engineering Institute, Carnegie Mellon University, August 2006

dance For Systems Assurance - 1

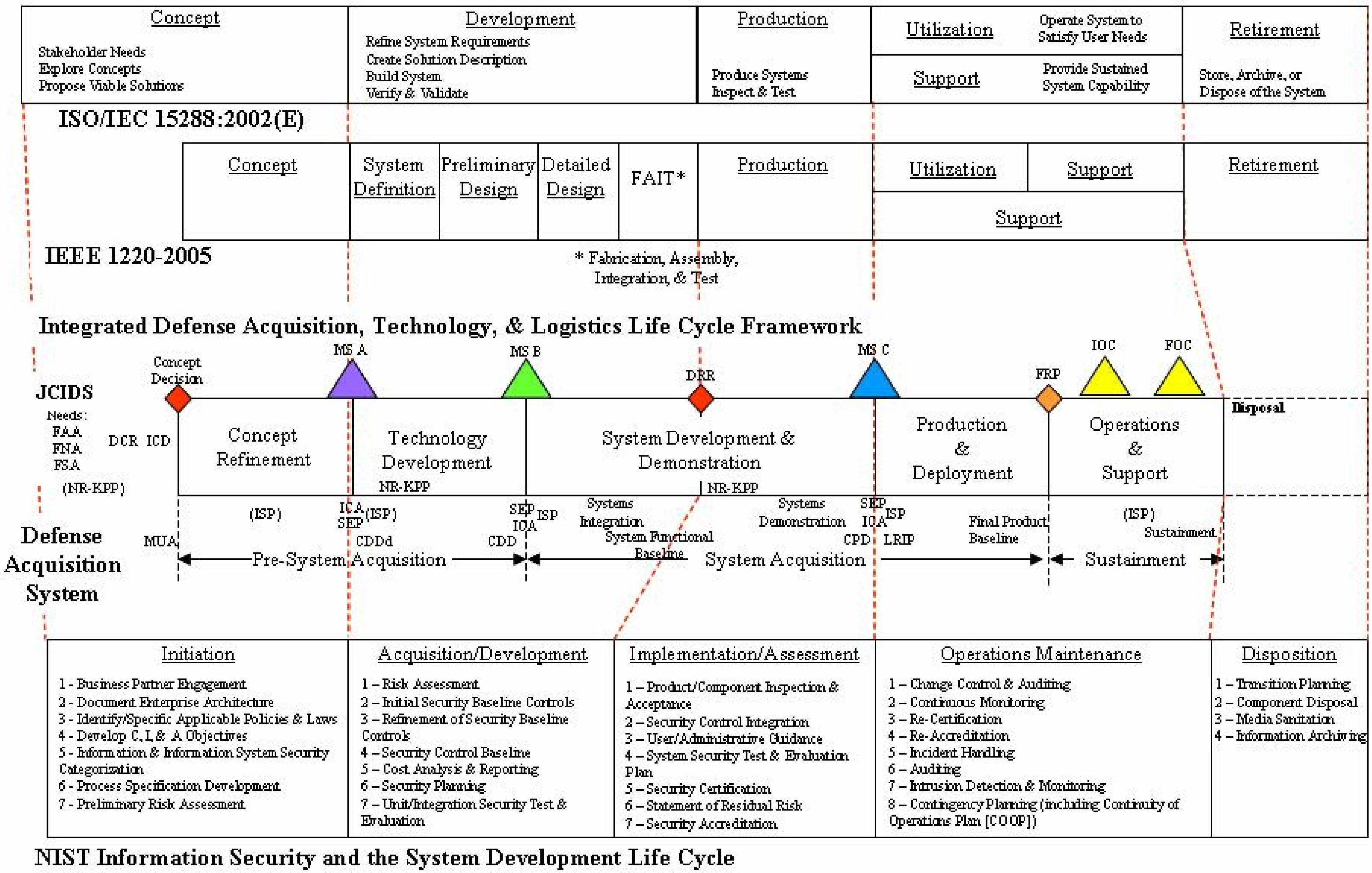
- ***Systems Assurance – Delivering Mission Success in the Face of Developing Threats***
  - An NDIA guidebook intended to supplement the knowledge of systems (and software) engineers who have responsibility for systems for which there are assurance concerns

System Assurance Guidebook ï Mapped To ISO/IEC/IEEE 15288

- Agreement Processes
  - Acquisition
  - Supply
- Project Processes
  - Project Planning
  - Project Assessment
  - Project Control
  - Decision-making
  - Risk Management
  - Configuration Management
  - Information Management
- **Assurance Case Process**
- Technical Processes
  - Stakeholder Requirements Definition
  - Requirements Analysis
  - Architectural Design
  - Implementation
  - Integration
  - Verification
  - Transition
  - Validation
  - Operation
  - Maintenance
  - Disposal

- Enterprise Processes
  - Enterprise Environment Management
  - Investment Management
  - System Life Cycle Process Management
  - Resource Management [including human resource training]
  - Quality Management

# of Standards In The Guidebook



dance For Systems Assurance - 2

- ***State of the Art Report on Software Security Assurance***
  - An IATAC/DACS report identifying and describing the current state of the art in software security assurance, including trends in:
    - Techniques for the production of secure software
    - Technologies that exist or are emerging to address the software security challenge
    - Current activities and organizations in government, industry, and academia, in the U.S. and abroad, that are devoted to systematic improvement of software security
    - Research trends worldwide that might improve the state of the art for software security

dance For Systems Assurance - 3

- ***Secure Software Assurance: A Guide to the Common Body of Knowledge to Produce, Acquire, and Sustain Secure Software***
  - ï A DHS guidebook intended as a framework to identify workforce needs for competencies and leverage standards and best practices to guide software-related curriculum development

dance For Systems Assurance - 4

- ***Security in the Software Life Cycle: Making Software Development Processes – and the Software Produced by Them – More Secure***
  - An DHS report providing a compendium of methodologies, life cycle process models, sound practices, and supporting technologies that would, if adhered to, increase software security

dance For Systems Assurance - 5

- ***Software Assurance in Acquisition: Mitigating Risks to the Enterprise***
  - ï A DHS report intended to provide guidance on enhancing supply chain management through improved risk mitigation and contracting for secure software

…ation In Support Of Assurance ï …ogramming Languages

- ISO/IEC SC22 ï OWG: Vulnerabilities (OWGV)
  - ï Project 22.24772: Guidance for Avoiding Vulnerabilities through Language Selection and Use
    - Technical Report
    - Comparative guidance spanning multiple programming languages
    - Goal: Avoidance of programming errors that lead to vulnerabilities

ation In Support Of Assurance ï IT Security Techniques

- ISO/IEC SC 27 IT Security Techniques
  - ï ISO/IEC 15408, Common Criteria for IT Security Evaluation
  - ï ISO/IEC 15443, FRITSA
    - Part 1: A framework for IT security assurance
    - Part 2: Assurance methods
    - Part 3: Analysis of assurance methods
  - ï ISO/IEC DTR 19791, Assessment of Operational Systems
  - ï ISO/IEC 21827, System Security Engineering Capability Maturity Model (SSE CMM) revision
  - ï ISO/IEC 27000 series ï Information Security Management System (ISMS)

ation In Support Of Assurance ï Functional Safety

- IEC SC 65A, Functional Safety
  - ï IEC 61508, Functional Safety Of Electrical/ Electronic/Programmable Electronic Safety-related Systems (7 parts)
    - Part 1: General requirements
    - Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems
    - Part 3: Software requirements
    - Part 4: Definitions and abbreviations
    - Part 5: Examples of methods for the determination of safety integrity levels
    - Part 6: Guidelines on the application of IEC 61508-2 and IEC 61508-3
    - Part 7: Overview of techniques and measures
  - ï Risk-based approach for determining the required performance of safety-related systems

ation In Support of Assurance ï Dependability

- IEC 60300 Series, Dependability Management
- IEC 61713, Software dependability through the software life-cycle processes- Application guide
- IEC 60812, Analysis techniques for system reliability - Procedure for failure mode and effects analysis (FMEA)
- IEC 61025, Fault tree analysis (FTA)

…ion In Support of Assurance ï …MA[1] Implementation

- **FIPS Publication 199**, Standards for Security Categorization of Federal Information and Information System
- **FIPS Publication 200**, Minimum Security Requirements for Federal Information and Federal Information Systems
- **NIST Special Publication 800-30, Revision 1**, Risk Assessment Guideline)
- **NIST Special Publication 800-37**, Guide for the Security Certification and Accreditation of Federal Information Systems
- **NIST Special Publication 800-39**, NIST Risk Management Framework
- **NIST Special Publication 800-53 Revision 1**, Recommended Security Controls for Federal Information Systems
- **NIST Special Publication 800-53A**, Guide for Assessing the Security Controls in Federal Information Systems
- **NIST Special Publication 800-59**, Guide for Identifying an Information System as a National Security System
- **NIST Special Publication 800-60**, Guide for Mapping Types of Information and Information Systems to Security Categories

[1]Federal Information Security Management Act of 2002
Source: http://csrc.nist.gov/sec-cert/ca-proj-phases.html

ation In Support Of Assurance ï Life Cycle Processes

ISO/IEC/IEEE 15026, System and Software Assurance

24748: Guide to Life Cycle Management

Other standards providing details of selected SW processes

Revised 12207: Life cycle processes for SW

Revised 15289: Document-ation

Interoperation

Revised 16326: Project Mgmt

Revised 15939: Measure-ment

Revised 16085: Risk Mgmt

Revised 15288: Life cycle processes for systems

Other standards providing details of selected system processes

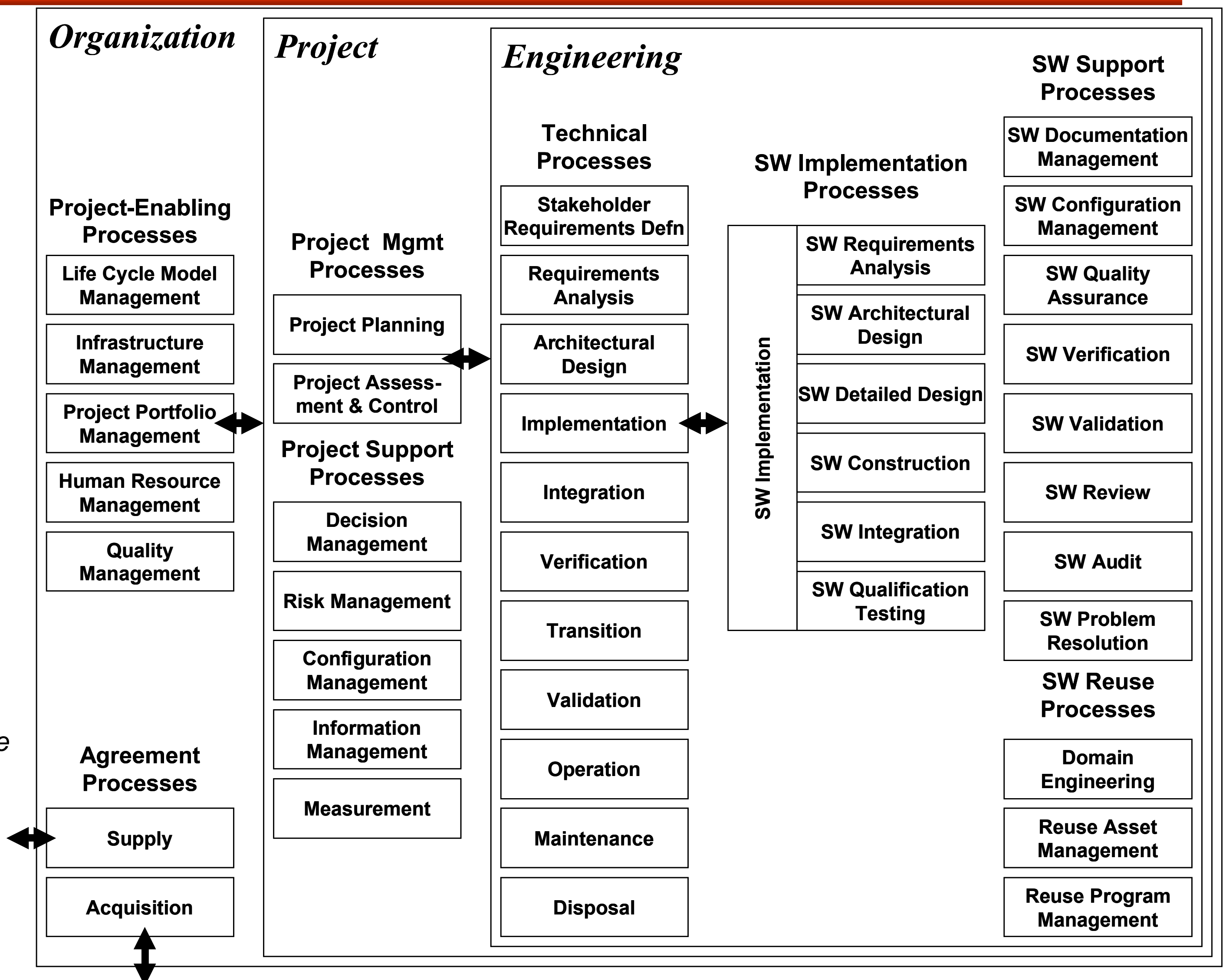
+

15026: Additional practices for higher assurance systems

Common vocabulary, process architecture, and process description conventions

Source: J. Moore, SC7 Liaison Report, IEEE Software and Systems Engineering Standards Committee, Executive Committee Winter Plenary Meeting, February 2007.

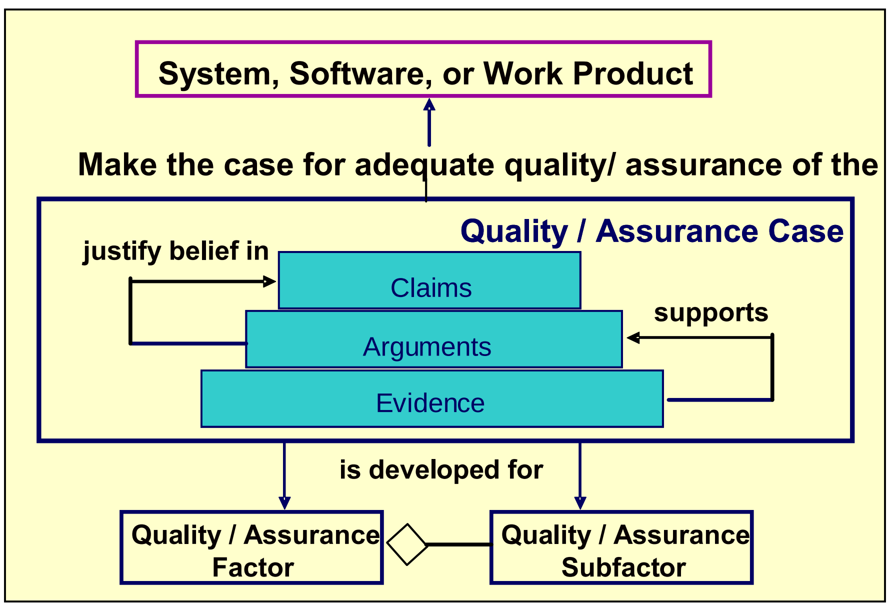
15288 And 12207 Life Cycle Processes



Source: ISO/IEC CD 15026/4 IEEE P15026/CD1, Systems and software engineering — Systems and software assurance

Of The Assurance Case

- **Set of structured assurance claims, supported by evidence and reasoning, that demonstrates how assurance needs have been satisfied.**
  - **Shows compliance with assurance objectives**
  - **Provides an argument for the safety and security of the product or service.**
  - **Built, collected, and maintained throughout the life cycle**
  - **Derived from multiple sources**



- **Sub-parts**
  - **A high level summary**
  - **Justification that product or service is acceptably safe, secure, or dependable**
  - **Rationale for claiming a specified level of safety and security**
  - **Conformance with relevant standards and regulatory requirements**
  - **The configuration baseline**
  - **Identified hazards and threats and residual risk of each hazard and threat**
  - **Operational and support assumptions**

Attributes

- Clear
- Consistent
- Complete
- Comprehensible
- Defensible
- Bounded
- Addresses all life cycle stages

References

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Software Assurance in Acquisition: Mitigating Risks to the Enterprise, Draft 1.0. U.S. Department of Homeland Security, March 2007.

More Information . . .

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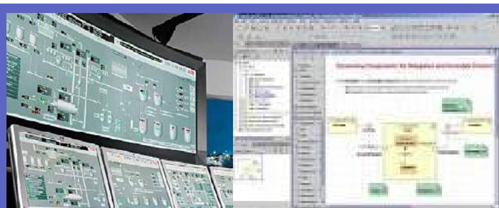
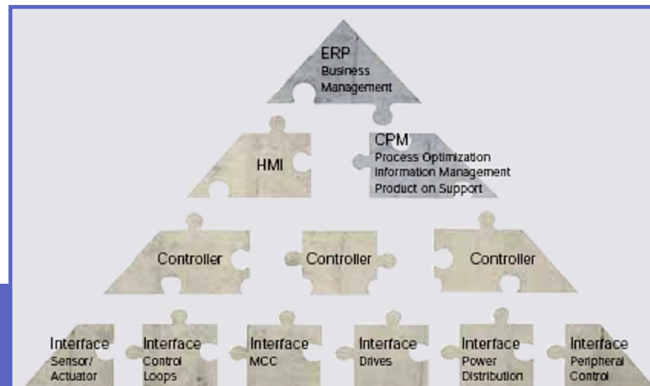
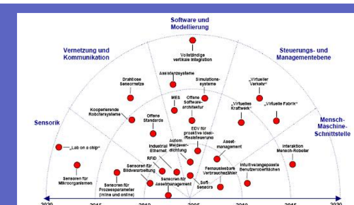
tecture Development Leveraging the Attribute Driven Design and the CMMI Methodologies

Dr Aldo Dagnino

ABB Inc. US Corporate Research Center







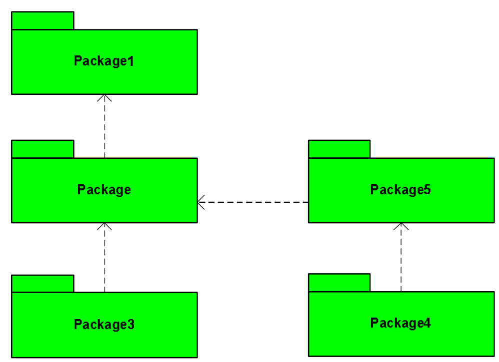
CMMI Technology Conference and User Group

November 12-15, 2007

Hyatt Regency Tech Center, Denver CO

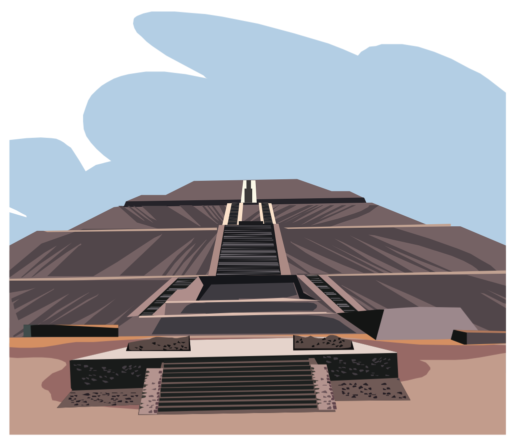
...bute Driven Design (ADD)

- ADD is a methodology used to define a system architecture that bases the decomposition process on the quality attributes the system (software) has to fulfill.
- The architectural design using the ADD methodology can begin when the architectural drivers are known with some level of confidence.
- In ADD Tactics and Architectural patterns are selected to satisfy a set of quality attributes within a critical scenario that provides context for those quality attributes

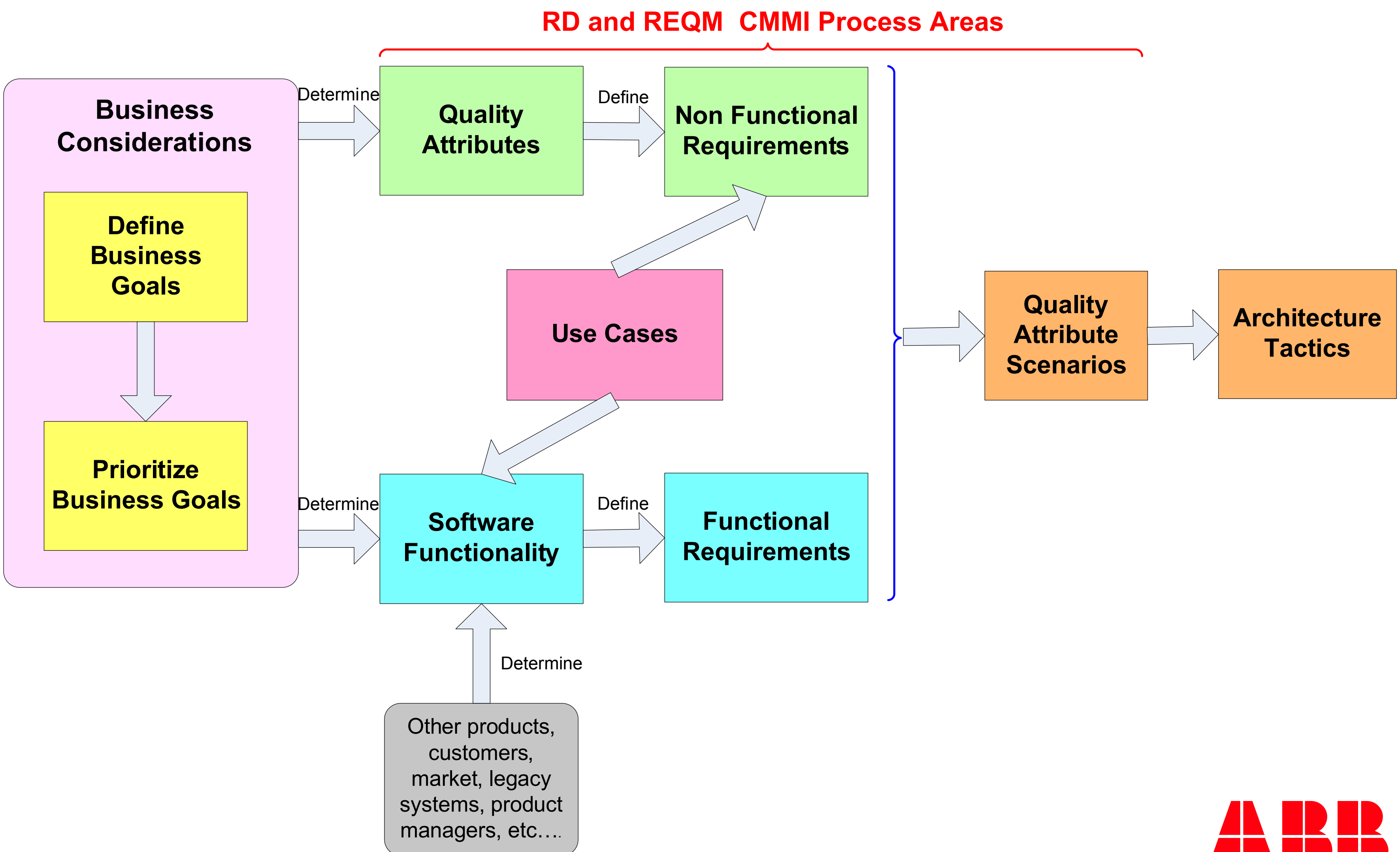


for Creating a Software Architecture

- Creating the business case for the system
- Understanding and documenting the requirements
- Leveraging Quality Attribute Scenarios
- Creating or selecting the architecture
- Documenting and communicating the architecture
- Analyzing or evaluating the architecture
- Implementing the system based on the architecture
- Ensuring that the implementation conforms to architecture



gration of ADD and CMMI



…s for Creating a Software Architecture

- **Creating the business case for the system**
- Understanding and documenting the requirements
- Leveraging Quality Attribute Scenarios
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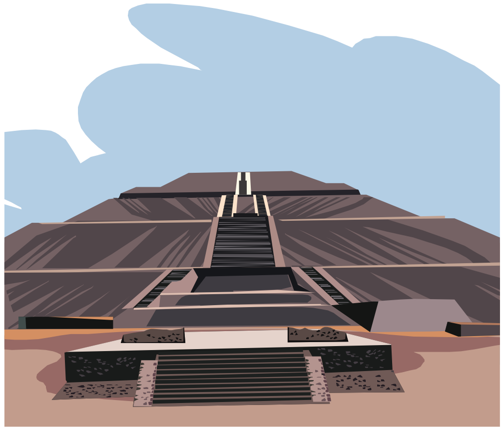


ess Goals

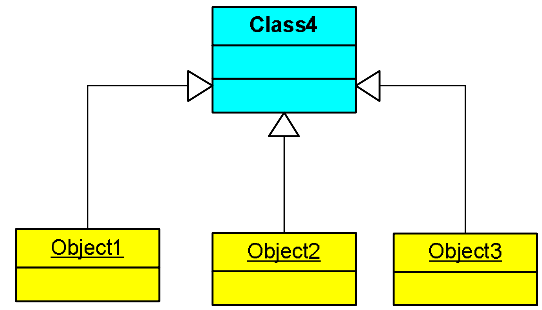
- **Prioritized Business Goals**
  - Business goals associated with the project are elicited from selected project stakeholders
  - Business goals are prioritized for stakeholders to guide architectural tradeoffs
- **Example of prioritized business goals:**
  - Lower commissioning costs by xx%
  - Ensure system is available 99.9%
  - Maintain current system performance
  - etc

g Business Goals and Quality Attributes

Business Goal	Quality Attributes
Lower commissioning costs by xx%	Commissionability
Ensure system is available 99.9%	Availability
Maintain current system performance	Performance

ectural Drivers

- Architectural drivers (quality attribute scenarios) include the combination of functional and quality requirements that shape the architecture:
  - Define unique functions (as architectural Functional Requirements) of modules in the system
  - Select associated Non-functional Requirements
  - Quality attribute scenarios provide the functional context under which Non Functional Requirements are defined
  - Architectural patterns that satisfy the critical scenarios are then selected



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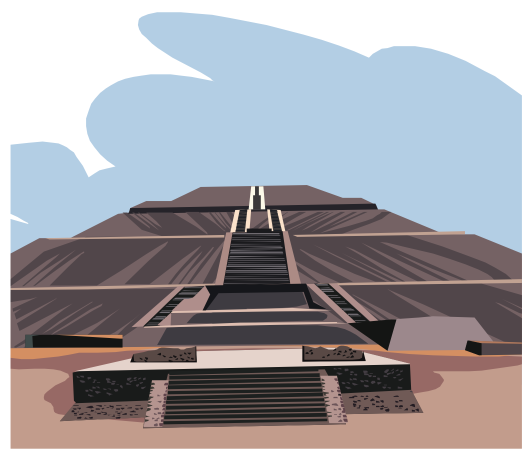
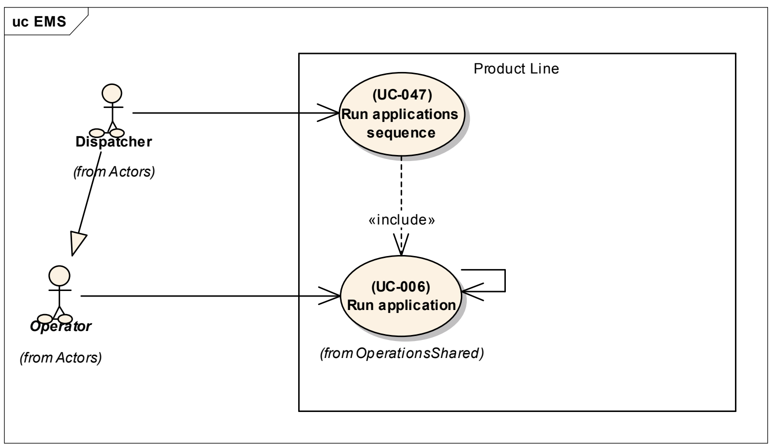


velop Customer (Architectural) Requirements -1-

SP 1.1 Elicit needs

SP 1.2 Develop the customer (architectural) requirements

Use Case
The operator runs a sequence of complex applications



Customer (Architectural) Requirements
Includes Functional and Non-functional requirements

The system shall allow the operator to run the state estimator application

The system shall allow the operator to run sensitivity analyses

The system shall allow the operator to run the PS model

The system shall allow the operator to run a sequence of applications in an “industry acceptable” time

etc . . .

velop Customer (Architectural) Requirements - 2-

SP 1.1 Elicit needs

SP 1.2 Develop the customer (architectural) requirements

Quality Attribute
System Quality

Customer-related Non Functional Requirements
Associated/derived from Quality Attribute

Commissionability

- The source code for the system shall not be modified for any customer implementation
- The software build shall be completed in an “acceptable” time period
- The complete system installation shall be completed in an “acceptable” time period

…elop Product (Architectural) Requirements -1-

SP 2.1 Establish product and product component requirements

SP 2.2 Allocate product component requirements

SP 2.3 Identify interface requirements

Customer Requirements Includes Functional and Non-functional requirements		**Product Architectural Requirements** Testable and measurable set of requirements
The system shall allow the operator to run the state estimator application	→	The system shall allow the operator to run the state estimator application in xx seconds
The system shall allow the operator to run sensitivity analyses	→	The system shall allow the operator to run sensitivity analyses in yy seconds per run
The system shall allow the operator to run the PS model	→	The system shall allow the operator to run the PS model in xy seconds
The system shall allow the operator to run a sequence of applications in an “industry acceptable” time	→	The system shall allow the operator to run a sequence of applications in yz seconds

…s for Creating a Software Architecture

- Creating the business case for the system
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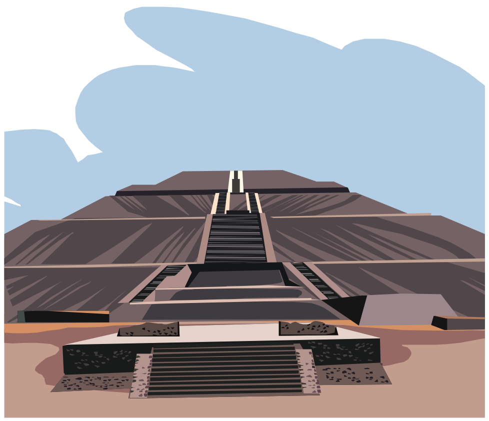
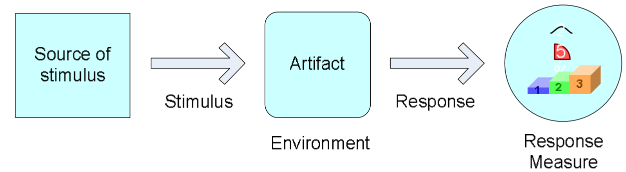
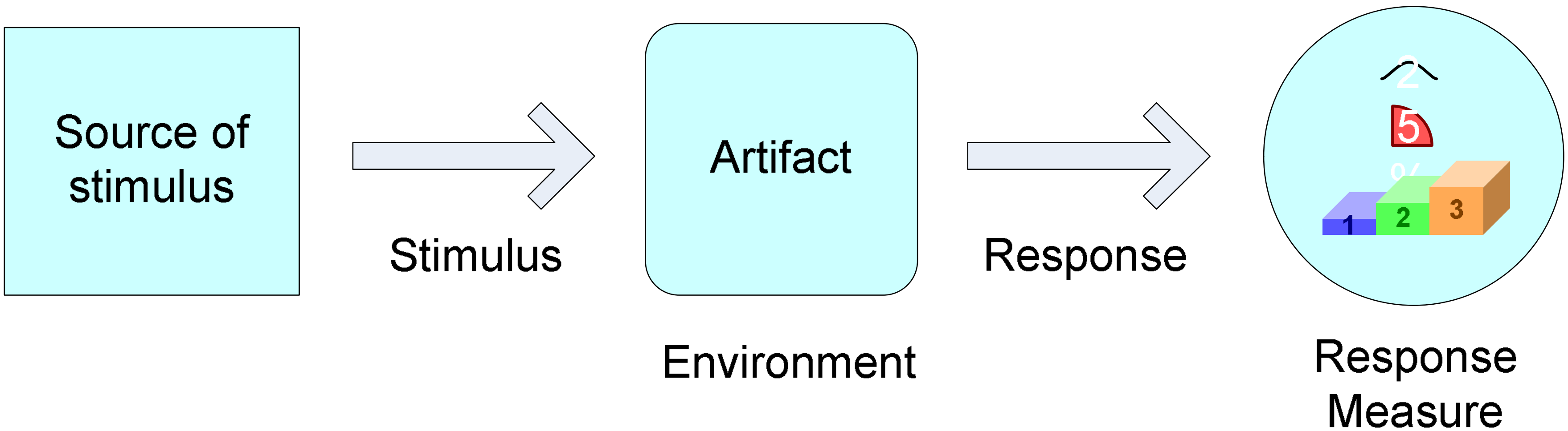


ty Attribute Scenarios



- **Encapsulate a set of architectural functional and non-functional requirements that uniquely define the system being architected**
- **Are described by a set of detailed architectural product requirements**
- **Can incorporate of one or more Use Cases**

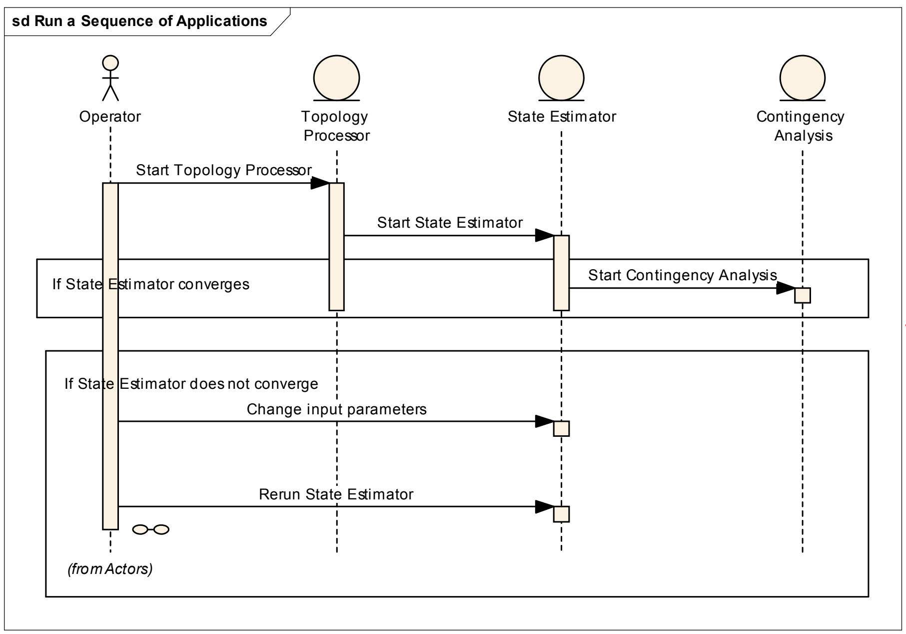
Attribute Scenario Elements



Analyze and Validate Requirements

SP 3.1 Establish operational concepts and scenarios
SP 3.2 Establish a definition of required functionality
SP 3.3 Analyze requirements
SP 3.4 Analyze requirements to achieve balance
SP 3.5 Validate requirements

Quality Attribute Scenario
Sequence Diagram



Detailed Architectural Non Functional Requirements
Placed in context of Critical Scenario

The time duration of sequence calculations shall be less than xx seconds under normal loading conditions

The performance of running the numerical application sequence shall be such that it will not exceed specified bounds of memory and CPU load capabilities

Manage Requirements

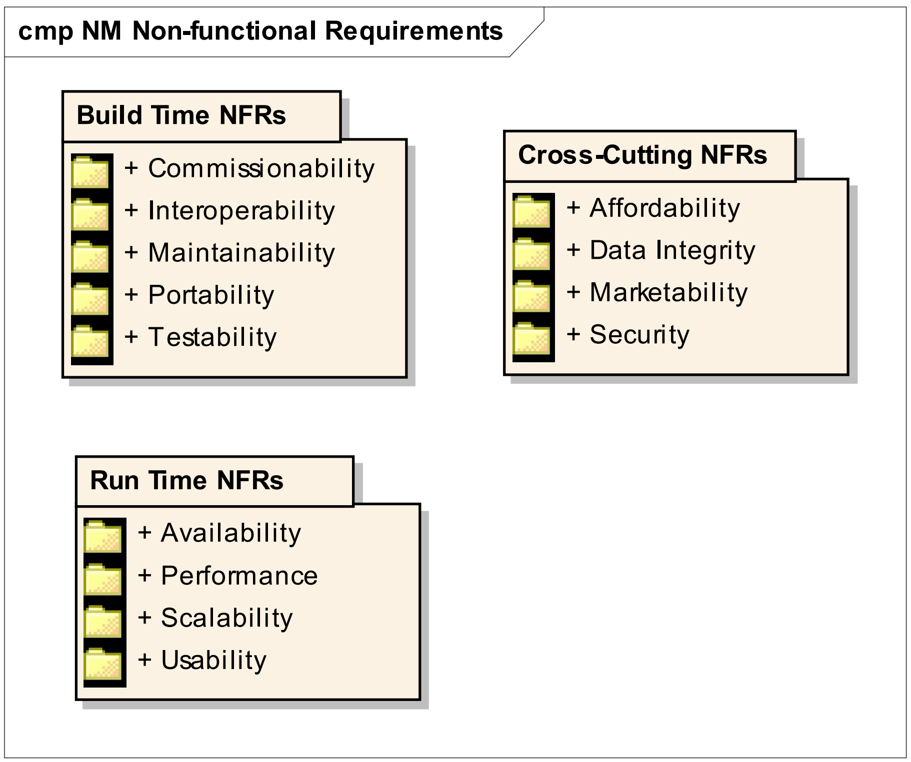
SP 1.1 Obtain an understanding of requirements

SP 1.2 Obtain commitment to requirements

SP 1.3 Manage requirements changes

SP 1.4 Maintain bi-directional traceability of requirements

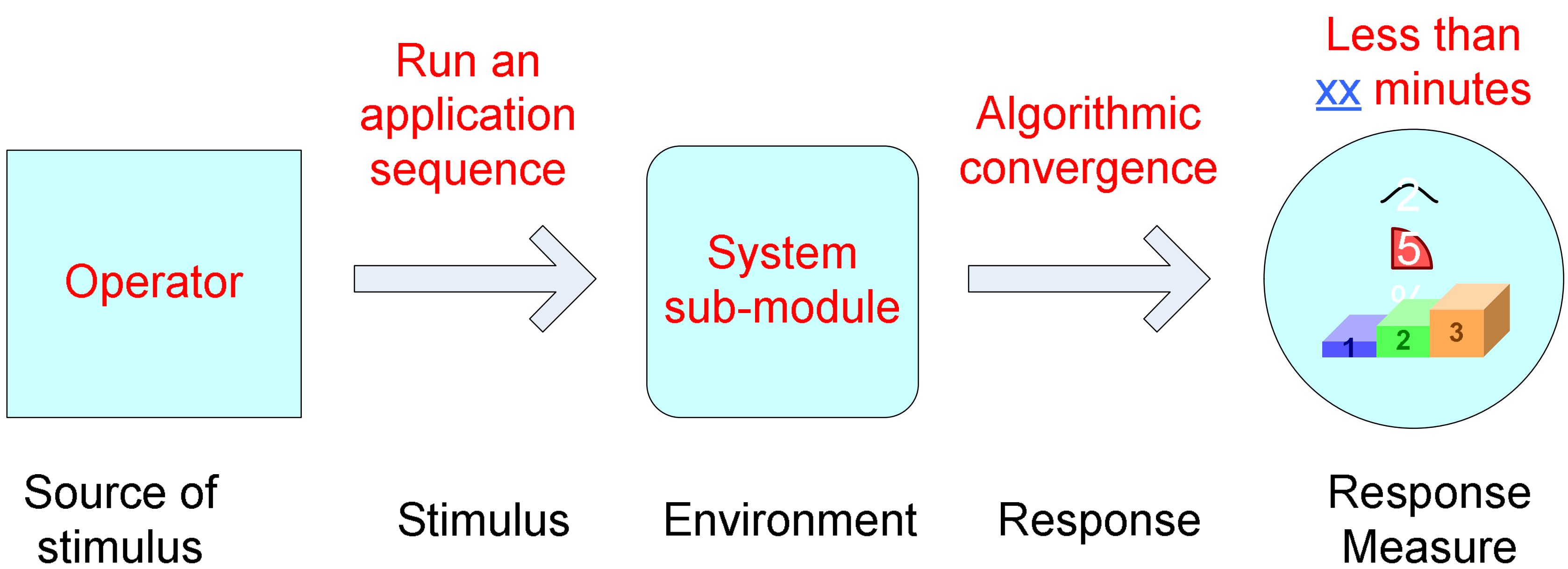
SP 1.5 Identify inconsistencies between project work and requirements



Understanding and commitment to requirements among stakeholders carried out through meetings

Functional and Non Functional requirements Stored, managed, and maintained in Enterprise Architect and Requisite Pro tools

Attribute Scenario: Run a Sequence of Applications



ons Learned

- The practices of the RD process area greatly contribute to defining the functional and non-functional architectural requirements that form the basis for ADD
- Organization business objectives are essential to establish priorities that drive the development of the architecture
- Quality attribute scenarios provide context to non-functional requirements
- To implement quality attribute scenarios, specific tactics identified in ADD provide architectural patterns

ABB

Power and productivity for a better world™

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Tools and Resources to Enable Systems Engineering Improvement

Michael T. Kutch, Jr.
SPAWAR Systems Center Charleston (SSC-C)
Head, Intelligence & Information Warfare Systems Engineering Department
National Competency Lead for I/A 5.8
Deputy National Competency Lead for ISR/IO 5.6

Mike Knox
Technical Software Services, Inc.
Director, Implementation and Support
SEI Authorized Instructor

7th Annual CMMI Technology Conference and Users Group
November 12-15, 2007

N65236-ENGOPS-BRIEF-0048-1.2

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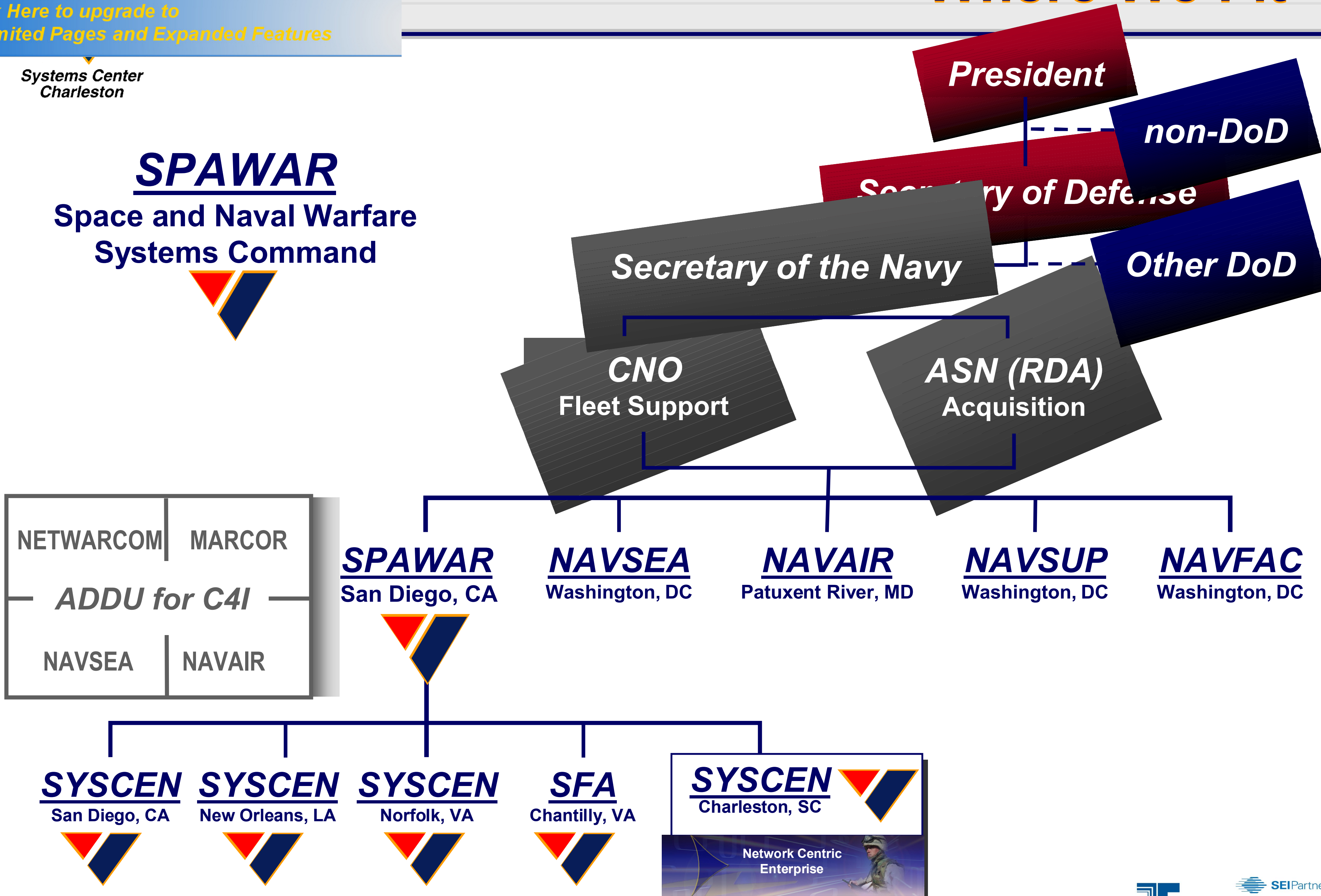
Where We Fit

SPAWAR

Space and Naval Warfare Systems Command



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What We Do

Systems Center Charleston

Connecting the Warfighter

Mission- We enable knowledge superiority to Naval and Joint Warfighters through the development, acquisition, and life-cycle support of effective, integrated C4ISR Information Technology, and Space capabilities.

Vision- Fully Netted in Three

We are the Principal C4I Acquisition Engineering & Integration Center on the East Coast & Principal C4ISR ISEA for the Navy

Connecting the Warfighter to the resources needed to win GWOT

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Presentation Outline

- **Vision and Strategy**
  - Elements of Implementation
- **Process Asset Library**
- **Tools**
  - ePlan Builder and eWBS
  - Organizational Measurement Repository
- **Training**
  - Training Architecture
  - Courses
- **Results**
- **Going Forward**

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Process Improvement and Systems Engineering Strategy - 2003

- **Vision**
  - Develop and maintain a World Class Systems Engineering Organization
- **Approach**
  - Achieve Command-wide operational consistency
  - Based on ISO 15288 ï systems engineering
  - Based on ISO 12207 ï software engineering
  - Measure using best practices of CMMI®
- **Goals**
  - CMMI Maturity Level 2 by April, 2005
  - CMMI Maturity Level 3 by April, 2007

Both Goals attained on schedule

1st SPAWAR Systems Center to Achieve ML2 and ML3

New Goal: Maturity Level 4 by 2010

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Which one is World Class?

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When you want it done right,
Who do you want working on it ?

Cutting corners, undisciplined, untrained

Rigorous processes, Skilled resources

Permission to use Redneck Mechanic photo received from Dave Lilligren, 3/9/2007
Permission to use NASCAR Technical Institute photo received from Popular Mechanics, 3/16/2007

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Critical Success Factors

CRITICAL SUCCESS FACTORS FOR SE REVITALIZATION	
Command-wide Policy (Create vision that is urgent)	Assign Responsibilities (Strong Change Agents are essential)
Strategy and Plan (Include knowledge of why change is necessary and benefits)	Provide Training
Senior Management Support	Build Central Repository
Provide Resources and Funding (New Organizational Structure Usually Needed)	Measure and Communicate Progress

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SSC-C SE Revitalization Plan Aligned with DoD SE Revitalization

Elements of SSC-C SE Revitalization

Policy / Guidance

- SSC-C SE Instruction
- SSC-C SE Process Manual
- SSC-C SW-Dev Process Manual
- SSC-C SW-Maint Process Manual
- EPO Website
- ePlan Builder

Training / Education

- Intro to PI WBT
- SE 101 WBT
- SE Fundamentals
- SE for Managers
- Project & Process Workshop
- Intro to Software Engr.
- Architecture Dev. WBT
- Certification/Degrees

Assessment & Support

- CMMI® Level 2
- CMMI® Level 3
- CMMI® Level 4/5
- Project Reviews
- Balanced Scorecard
- Lean Six Sigma
- Integrated Product Teams
- IT Tools

Underway

Completed/Ongoing

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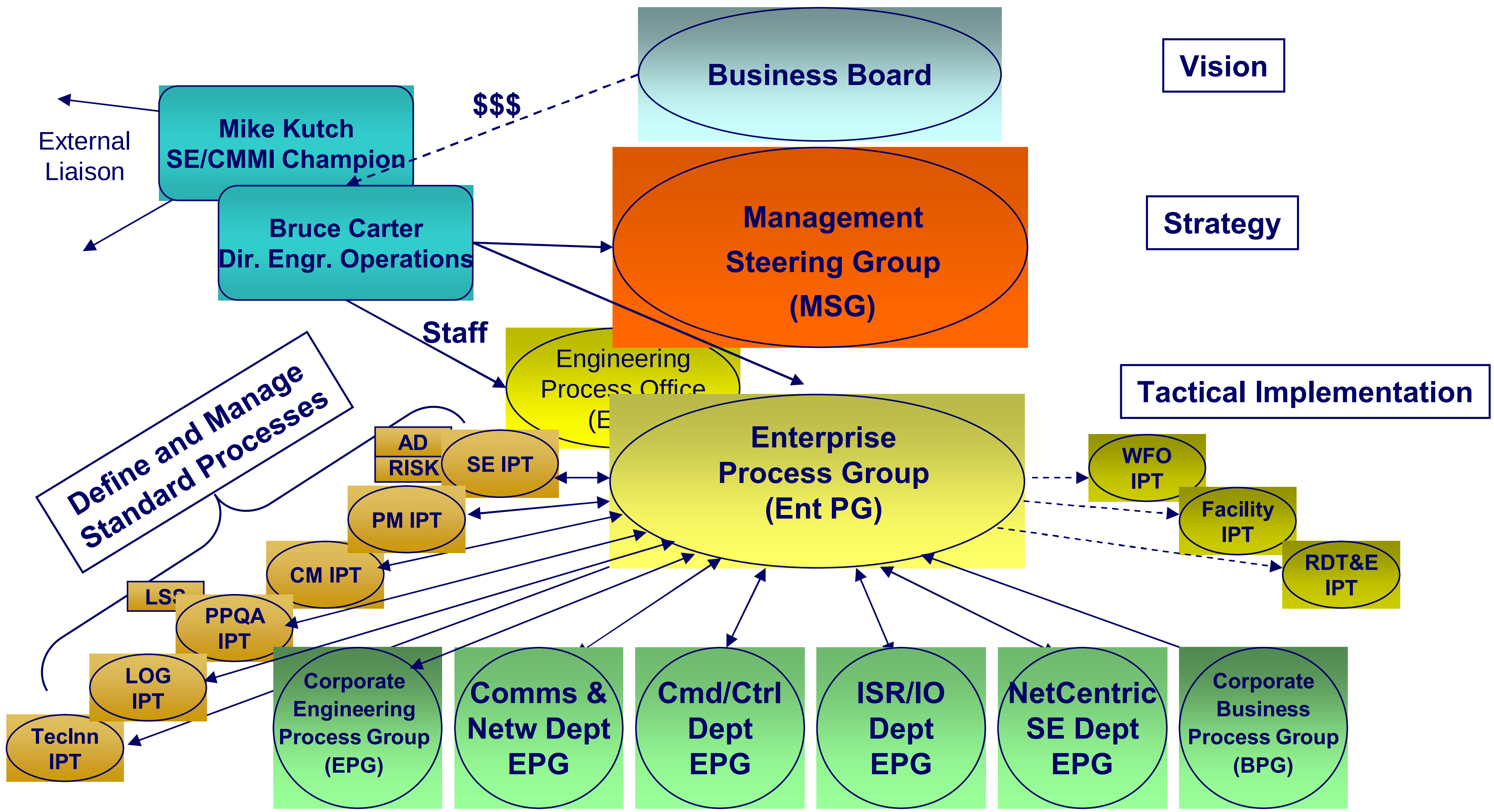
Process Improvement Infrastructure: Organization



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Engineering Process Office (EPO)

Engineering Process Office (EPO)

ÅSupports the Director of Engineering Operations

ÅDeveloped Policies

- ï Policy for each CMMI Level 2, 3, 4, & 5 Process Area

ÅDeveloped Standard Process Manuals

- ï Top Level
  - Å Systems Engineering
  - Å Software Development
  - Å Software Maintenance
- ï Supporting Processes
  - Å Process Manual for each CMMI Level 2, 3, 4, & 5 Process Areas
  - Å Additional process documentation as needed ï Reviews, Tailoring, etc

ÅDevelop plan templates

ÅCoach and mentor selected projects

ÅBuild tools

ÅDevelop and deliver training

ÅPerform interim assessments

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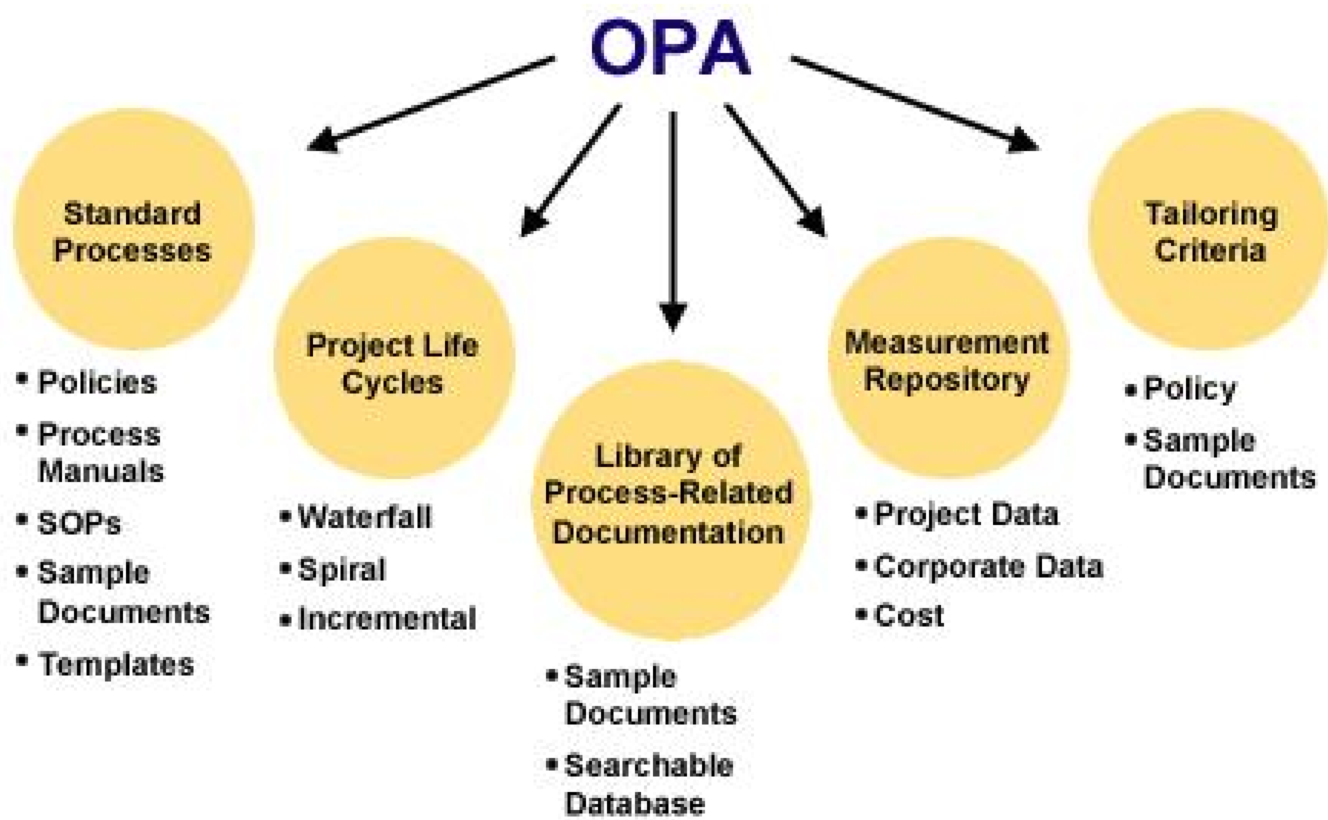
Process Asset Library

Recognized early need for central repository for Organizational Process Assets



EPO website provides access to all SSC-C's organizational process assets

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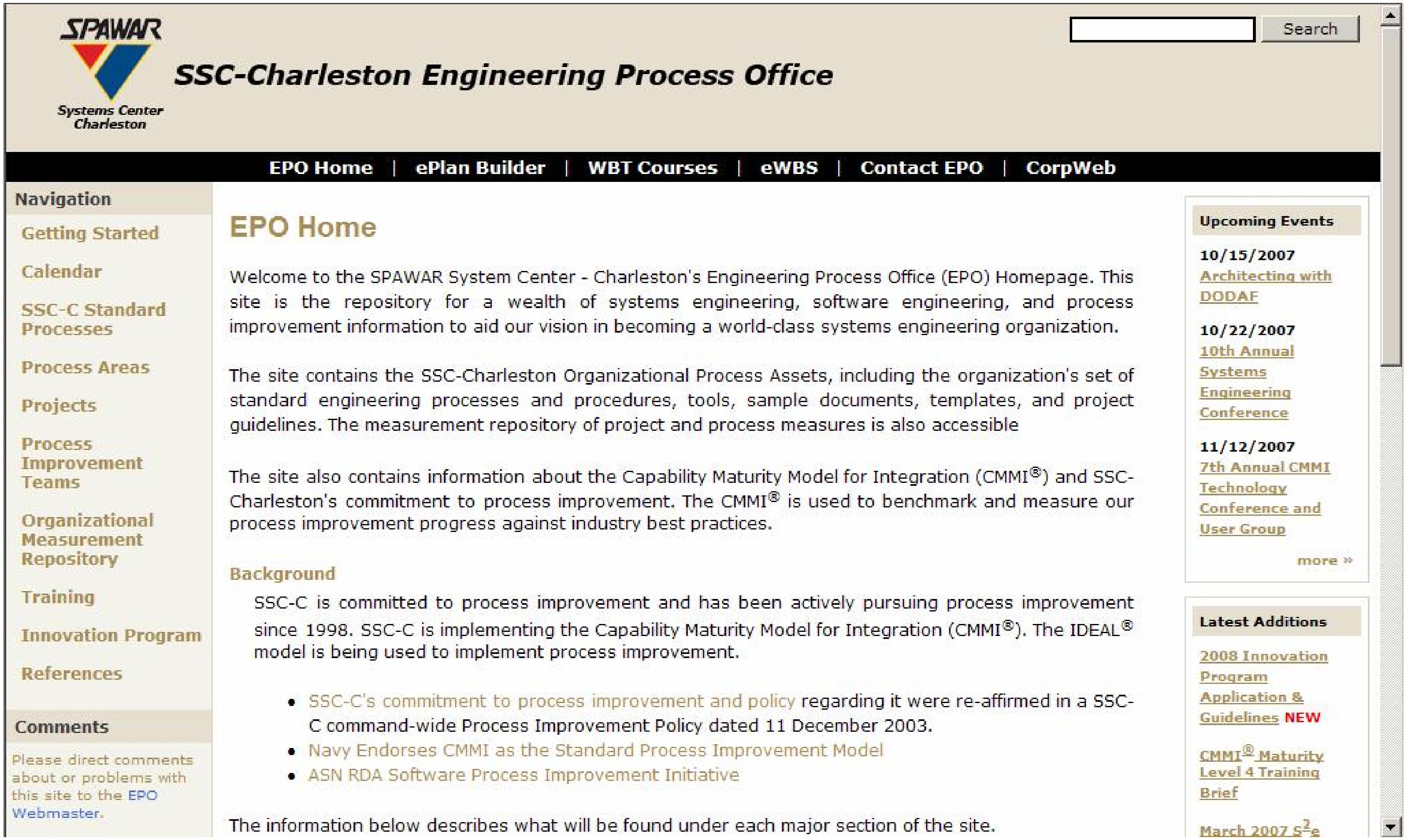
Approximately 100 pages of content; over 1000 documents available



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Search

SSC-Charleston Engineering Process Office

EPO Home | ePlan Builder | WBT Courses | eWBS | Contact EPO | CorpWeb

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- Process Areas
- Projects
- Process Improvement Teams
- Organizational Measurement Repository
- Training
- Innovation Program
- References

Comments

Please direct comments about or problems with this site to the EPO Webmaster.

EPO Home

Welcome to the SPAWAR System Center - Charleston's Engineering Process Office (EPO) Homepage. This site is the repository for a wealth of systems engineering, software engineering, and process improvement information to aid our vision in becoming a world-class systems engineering organization.

The site contains the SSC-Charleston Organizational Process Assets, including the organization's set of standard engineering processes and procedures, tools, sample documents, templates, and project guidelines. The measurement repository of project and process measures is also accessible

The site also contains information about the Capability Maturity Model for Integration (CMMI®) and SSC-Charleston's commitment to process improvement. The CMMI® is used to benchmark and measure our process improvement progress against industry best practices.

Background

SSC-C is committed to process improvement and has been actively pursuing process improvement since 1998. SSC-C is implementing the Capability Maturity Model for Integration (CMMI®). The IDEAL® model is being used to implement process improvement.

- SSC-C's commitment to process improvement and policy regarding it were re-affirmed in a SSC-C command-wide Process Improvement Policy dated 11 December 2003.
- Navy Endorses CMMI as the Standard Process Improvement Model
- ASN RDA Software Process Improvement Initiative

The information below describes what will be found under each major section of the site.

Upcoming Events

10/15/2007
Architecting with DODAF

10/22/2007
10th Annual Systems Engineering Conference

11/12/2007
7th Annual CMMI Technology Conference and User Group

more »

Latest Additions

2008 Innovation Program Application & Guidelines NEW

CMMI® Maturity Level 4 Training Brief

March 2007 S^2e

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Process Area Pages

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  - Project Monitoring & Control (PMC)
  - Configuration Management (CM)
  - Process and Product Quality Assurance (PPQA)
  - Requirements Management (REQM)
  - Measurement & Analysis (MA)
  - Supplier Agreement Management (SAM)
  - Requirements Development (RD)
  - Technical Solution (TS)

Project Monitoring & Control (PMC)

Project Monitoring and Control (PMC) is a Level 2 (Managed) Process Area. The purpose of PMC is to provide an understanding of the project's progress so that appropriate corrective actions can be taken when the project's performance deviates significantly from the plan.

Policy Document

- SSC-C Project Monitoring and Control Policy

Process Manual

- SSC-C Project Monitoring and Control Process Manual

SOPs

- In Process Review SOP
- Project Management Review SOP
- Meeting SOP

Sample Documents

- IBFTC PMC Plan
- CICS Project Management Plan (PMP)
- Towed Array Earned Value Plan

Templates

- PMP Plan

Related Process Areas

- Project Planning (PP)
- Measurement & Analysis (MA)

Each CMMI process area has a standard page with links to policy, process manual, SOPs, Sample/Project documents, and other resources

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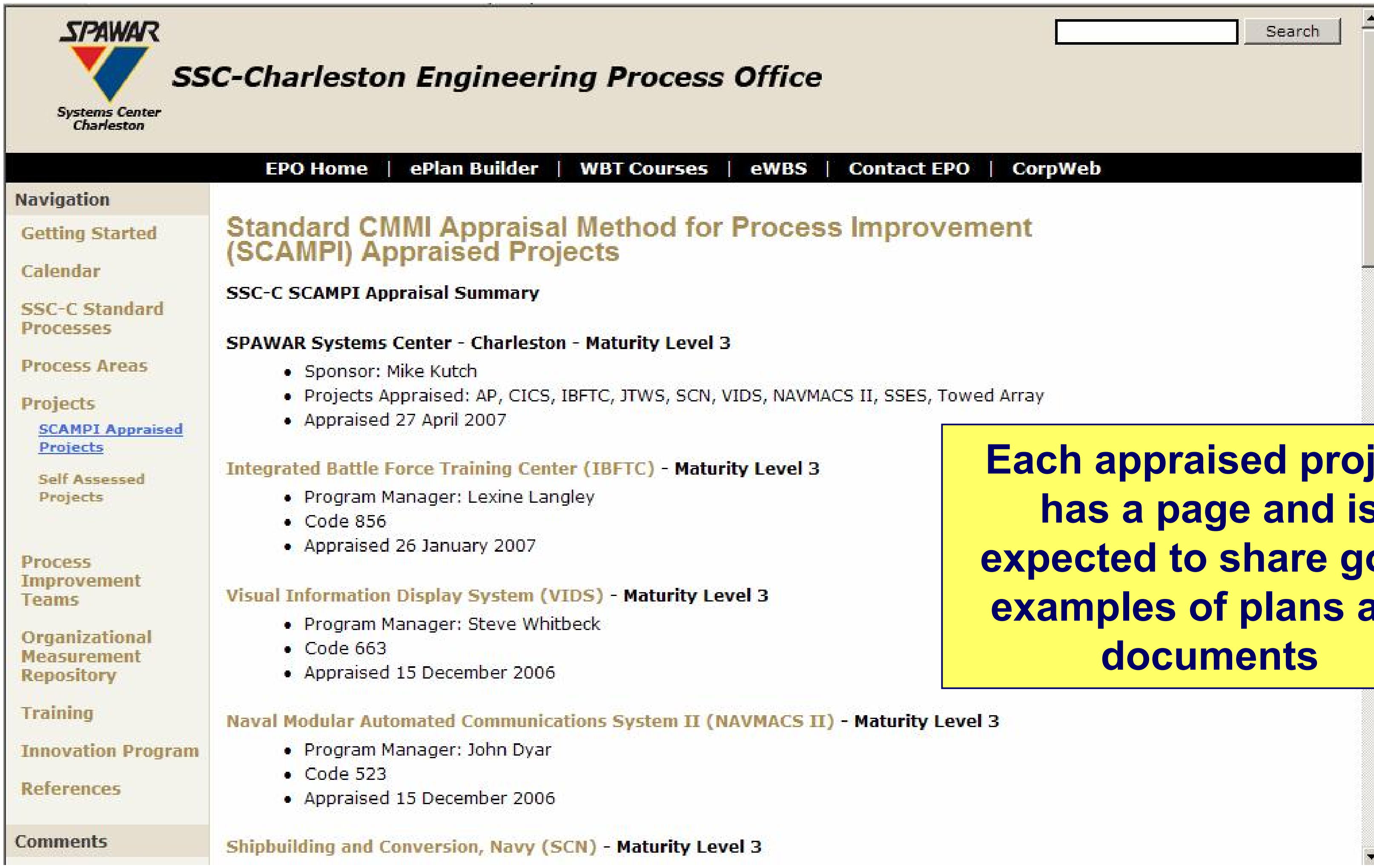
Projects Section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  - Self Assessed Projects
- Process Improvement Teams
- Organizational Measurement Repository
- Training
- Innovation Program
- References

Comments

Standard CMMI Appraisal Method for Process Improvement (SCAMPI) Appraised Projects

SSC-C SCAMPI Appraisal Summary

SPAWAR Systems Center - Charleston - Maturity Level 3

- Sponsor: Mike Kutch
- Projects Appraised: AP, CICS, IBFTC, JTWS, SCN, VIDS, NAVMACS II, SSES, Towed Array
- Appraised 27 April 2007

Integrated Battle Force Training Center (IBFTC) - **Maturity Level 3**

- Program Manager: Lexine Langley
- Code 856
- Appraised 26 January 2007

Visual Information Display System (VIDS) - **Maturity Level 3**

- Program Manager: Steve Whitbeck
- Code 663
- Appraised 15 December 2006

Naval Modular Automated Communications System II (NAVMACS II) - **Maturity Level 3**

- Program Manager: John Dyar
- Code 523
- Appraised 15 December 2006

Shipbuilding and Conversion, Navy (SCN) - **Maturity Level 3**

Each appraised project has a page and is expected to share good examples of plans and documents

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Tools

- ePlan Builder
- Organizational Measurement Repository
- Appraisal Wizard

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ePlan Builder Tool

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ePlan Builder tool

- An interactive, web-based application that leads the user through a structured interview process (like TurboTax®) to generate a CMMI®-compliant plan
- Includes standard, consistent text
- Generates an initial project-specific document
  - Project Management Plan (with Work Breakdown Structure)
  - Configuration Management Plan
  - Process and Product Quality Assurance Plan
  - Requirements Management Plan
  - Measurement and Analysis Plan
  - Supplier Agreement Management Plan (by end of 2007)
  - Systems Engineering Plan (DoD SEP Format)

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EPB – Select Tasks for each Role

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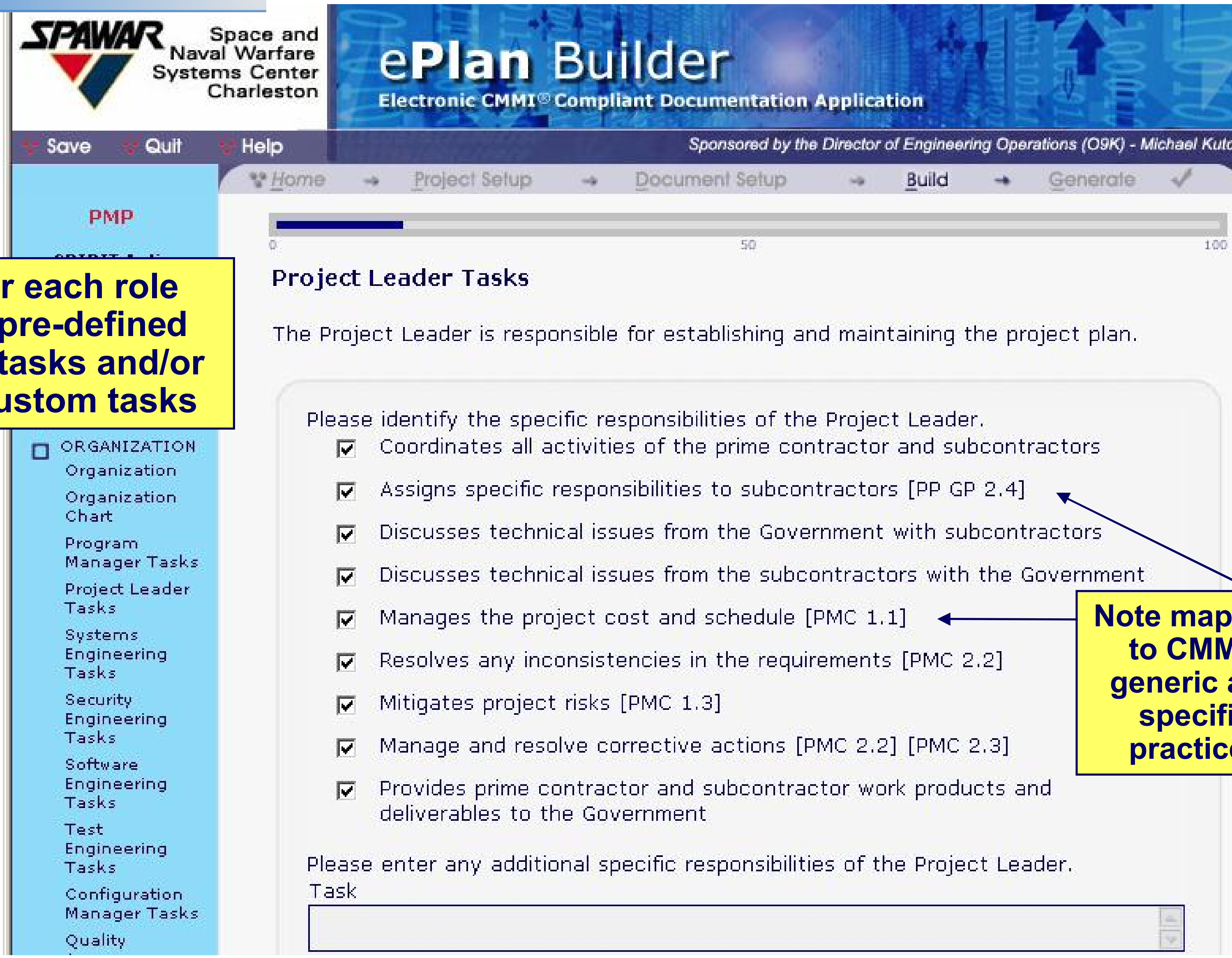
Tailor each role from pre-defined list of tasks and/or add custom tasks



Note mapping to CMMI® generic and specific practices

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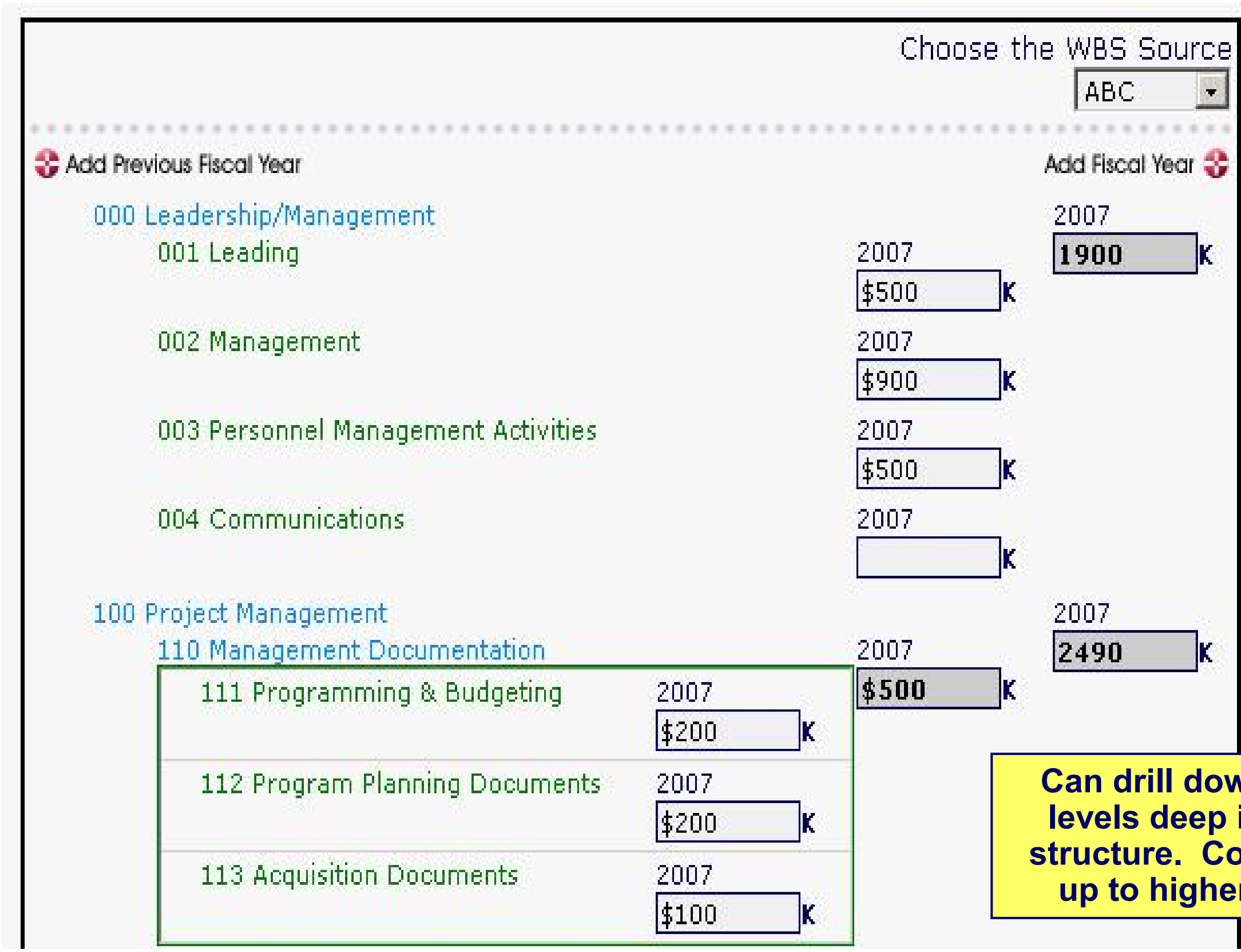
Work Breakdown Structure (WBS) in a Project Management Plan



Cost estimates entered using the SPAWAR global WBS or the SSC-C Activity Based Costing WBS

ePB accommodates multi-year projects

Can drill down three levels deep in WBS structure. Costs sum up to higher level.

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Risk Identification in PMP

Risks

This page allows you to enter a list of known or expected risks. The severity of the risks and the mitigation approach for each should be identified. Please use the table below to identify the major risks associated with the project.

Click for more information about risks

Risk Category	Impact/Concern	Level	Mitigation Approach
Schedule	Products are required by the customer by 10/1/06	High	Be prepared to provide draft materials if development of
Quality	Will products be ready for 10/15/06 in a condition	Medium	Provide technical data to contractor in accordance with schedule with
Technical	Ability to get teh technical ata from the	High	Interact directly with the satellite manufacturer to obtain the technical

Add More Items

PMP may also reference a more comprehensive Risk Management Plan

Measurement & Analysis Plan

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Cost, Schedule, and Process Performance are standard categories of measures

Collection, Storage, and Analysis is defined for each Project measure

Cost is a measure within the Financial Performance category that measures the cost for activities, events, and products. The measure provides an easy-to understand view of the budget. Comparison of planned and actual cost data provides insight into significant and repetitive cost changes at the activity level.

While more detailed cost information provides more insight into the project's total cost, until the project personnel have achieved a certain level of proficiency in estimating costs, it is recommended that the cost data should be captured at a level commensurate with this level of experience.

Collection and Storage

Identify the level of detail for capturing cost data

Project Level

Please select how the Project Leader will report contract costs from the list below. If the Project Leader is not responsible for managing contracts, select "Project".

Project

Identify who will provide the actual cost data:

Project Leader

Identify the tool to be used to collect cost data:

BSA and PMACS

Identify how often the actual cost data will be collected:

Monthly

Analysis Procedures

Identify how often the cost data will be analyzed:

Monthly

Identify the cost alert threshold:

95%

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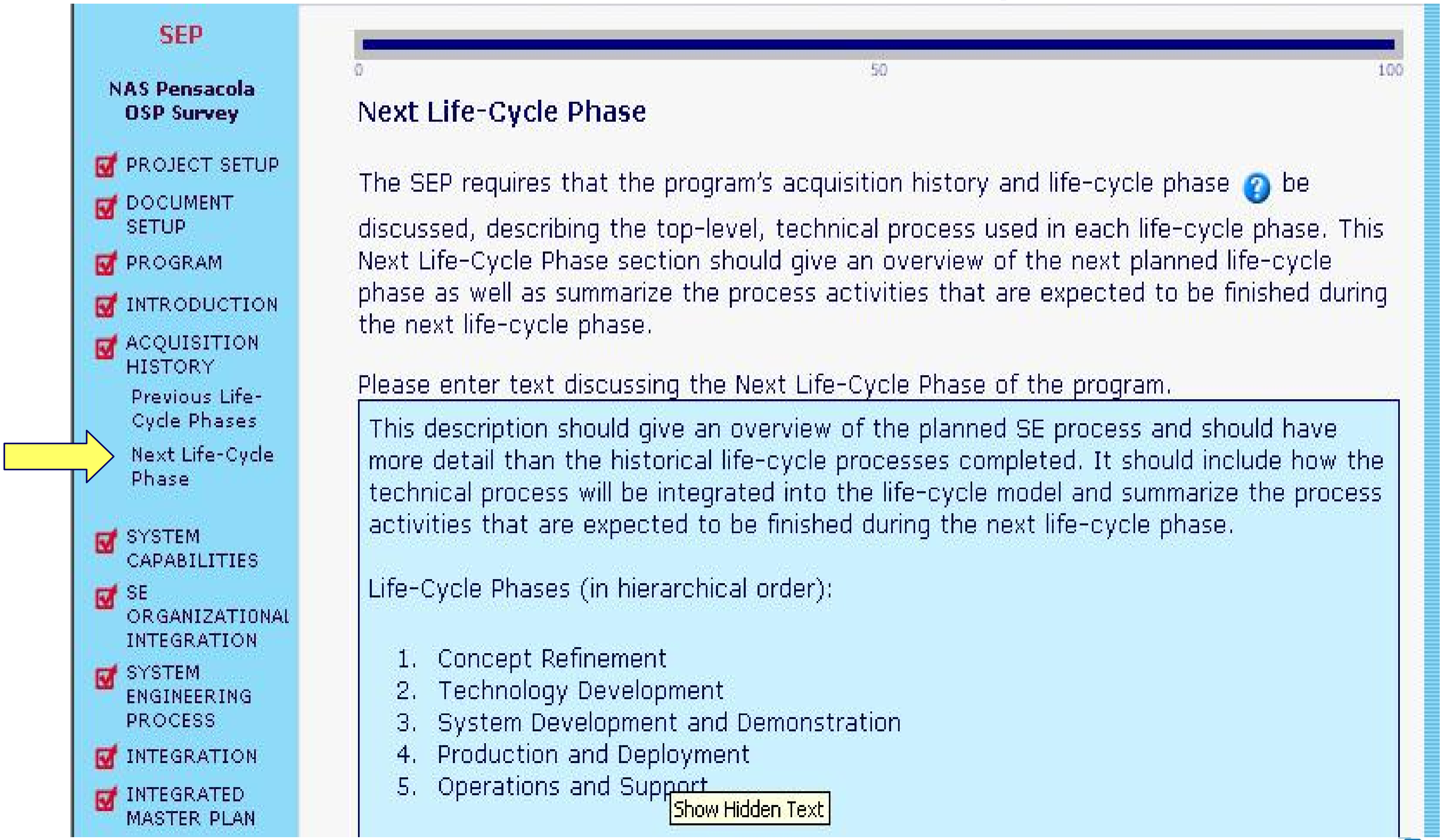
Systems Engineering Plan (SEP)

SEP format follows the DoD SEP Preparation Guide



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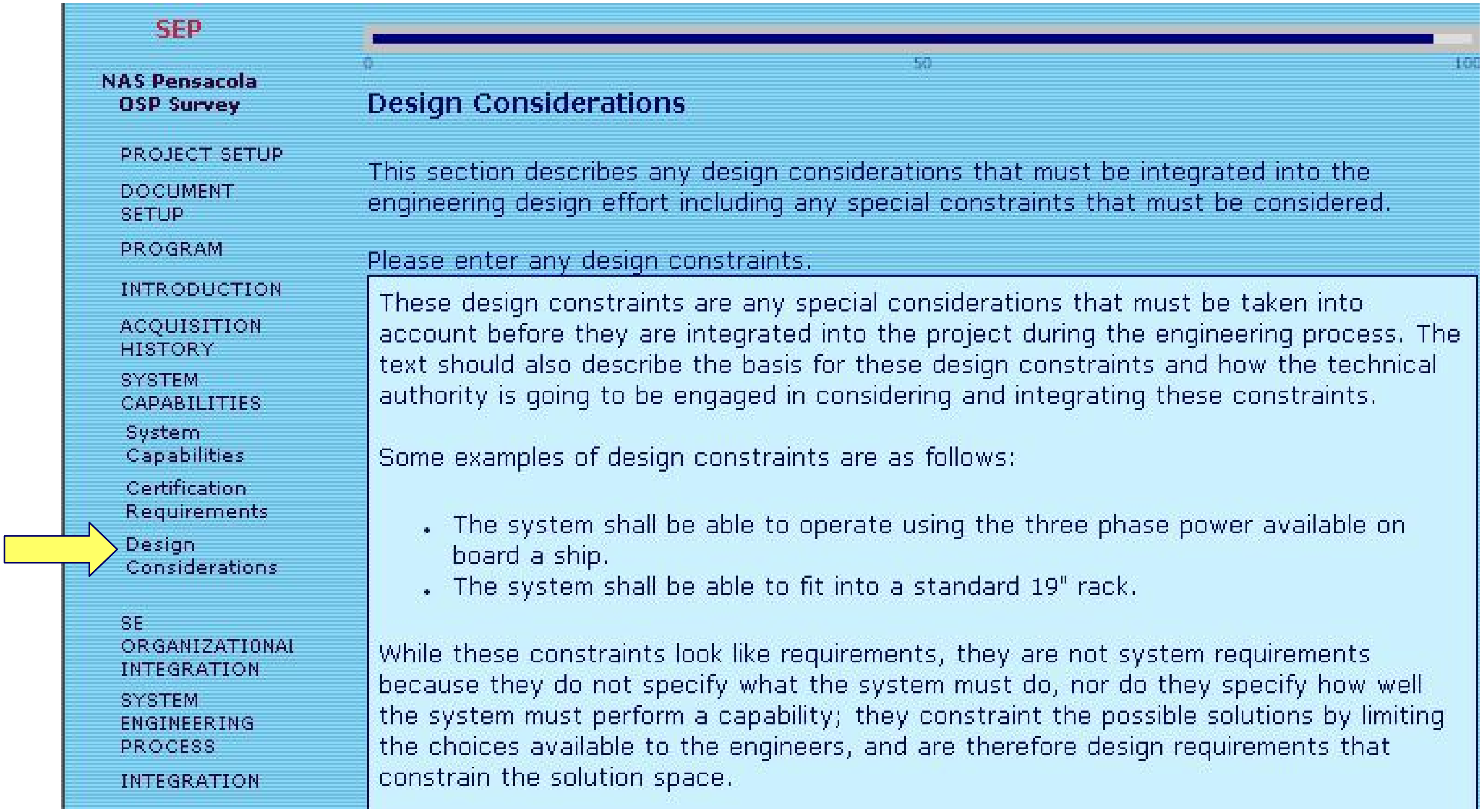
Systems Engineering Plan (SEP)

Systems Center Charleston



The nature of the SEP requires more open input text fields, but EPB helps by providing elaborations and examples for the user

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SEP – Planned Trade Studies

SEP

NAS Pensacola OSP Survey

- PROJECT SETUP
- DOCUMENT SETUP
- PROGRAM
- INTRODUCTION
- ACQUISITION HISTORY
- SYSTEM CAPABILITIES
- SE ORGANIZATIONAL INTEGRATION
- SYSTEM ENGINEERING PROCESS
  - Planning
  - Process Improvement
  - Modeling and Simulation
  - Resources
  - Trade Studies
- INTEGRATION
- INTEGRATED

0 50 100

Trade Studies

This section should include a brief description of the process used to determine trade-offs between various attributes of the program (e.g., between requirements and design). Information about how trade studies are addressed within the organization will be automatically embedded into the document. To view the embedded information about how trade studies will be addressed, click the "Click to view the embedded trade studies text" link below.

Click to view the embedded trade studies text.

Trade studies will be addressed in accordance with the *SSC-C Technical Solutions Process Manual* and *SSC-C Decision Analysis and Resolution Process Manual* where the development of alternate solutions, selection criteria and trade processes are discussed.

The actual trade studies to be performed on the program will be captured and listed in the control below.

Please enter the trade studies that will be conducted on this program.

Trade Study

Research on OSP topologies

Trade Study

Research on different conduit installation

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ePB Output
SEP Table of Contents

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SPAWAR

N65236-593-PMP-0001v1
August 18, 2006

Project Management Plan (PMP)

For

MARSOC West SCAMPI CER (593)

August 18, 2006

Prepared by:

Space and Naval Warfare Systems Center, Charleston
(SSC-C)
(593)
P. O. Box 190022
North Charleston, SC 29419-5542

Approved by: Mark Renaud (593) Date: August 23, 2006

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Appendix – CMMI® Compliance Matrix

N65236-593-PMP-0001-v1
August 18, 2006

PROJECT PLANNING

CMMI®-SE/SW Goal/Practice Number	CMMI®-SE/SW Level 2 Process Area Project Planning (PP)	SSC-C PP Process Manual Paragraph	593 PMP Paragraph
1	Establish Estimates. Estimates of project planning parameters are established and maintained.	3.2	1.2.1
PP 1.1	Estimate the Scope of the Project. Establish and maintain a top-level work breakdown structure (WBS) to estimate the scope of the project.	3.2	1.2.1 3 Appendix A
PP 1.2	Establish Estimates of Project Attributes. Establish and document estimates of the attributes of the work products and tasks.	3.2	1.2.1 1.3
PP 1.3	Define Project Life Cycle. Define the project life cycle phases upon which to scope the planning effort.	3.2	1 1.2.1
PP 1.4	Determine estimates of Effort and Cost. Estimate the project effort and cost for the attributes of the work products and tasks based on estimation rationale.	3.2	1.3 1.2.1 Appendix A
PP 2	Develop a Project Plan. A project plan is established and maintained as the basis for managing the project.	3.3	1 1.2.1

Compliance matrix cross references CMMI® practices with associated SSC-C Process Manual and Project-specific plan

(No matrix for SEP)

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ational Measurement Repository (OMR)

- Organizational database for collecting standard project measures and providing analysis
- Currently, the OMR accepts the following standard project measures

Category	Core Measure
Schedule Performance	• Estimated vs. Actual Milestone dates • Estimated vs. Actual Monthly Task completions
Cost Performance	• Estimated vs. Actual Milestone costs • Estimated vs. Actual Monthly costs
Process Performance	• Total # of noncompliance issues

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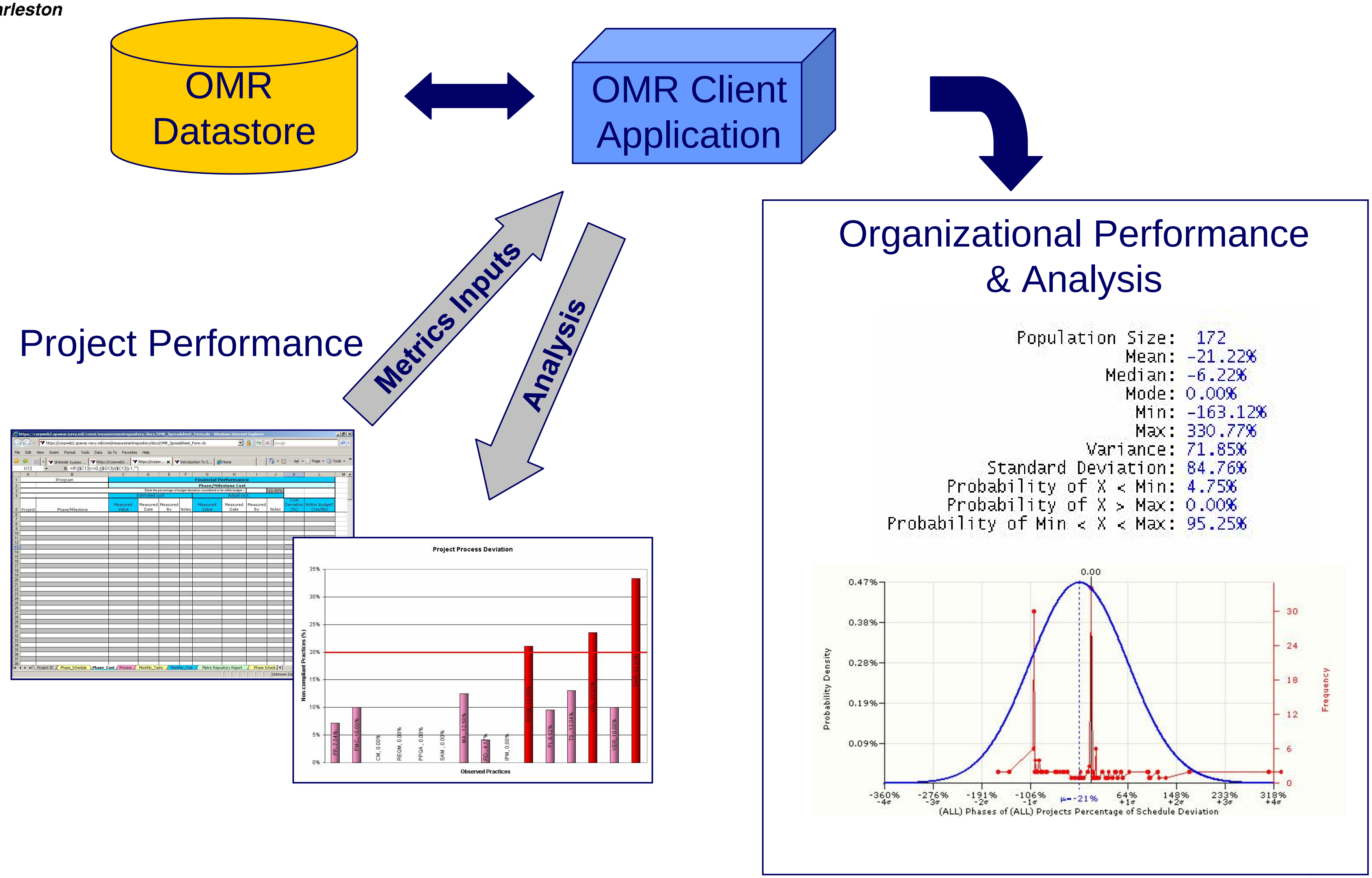
OMR Structure



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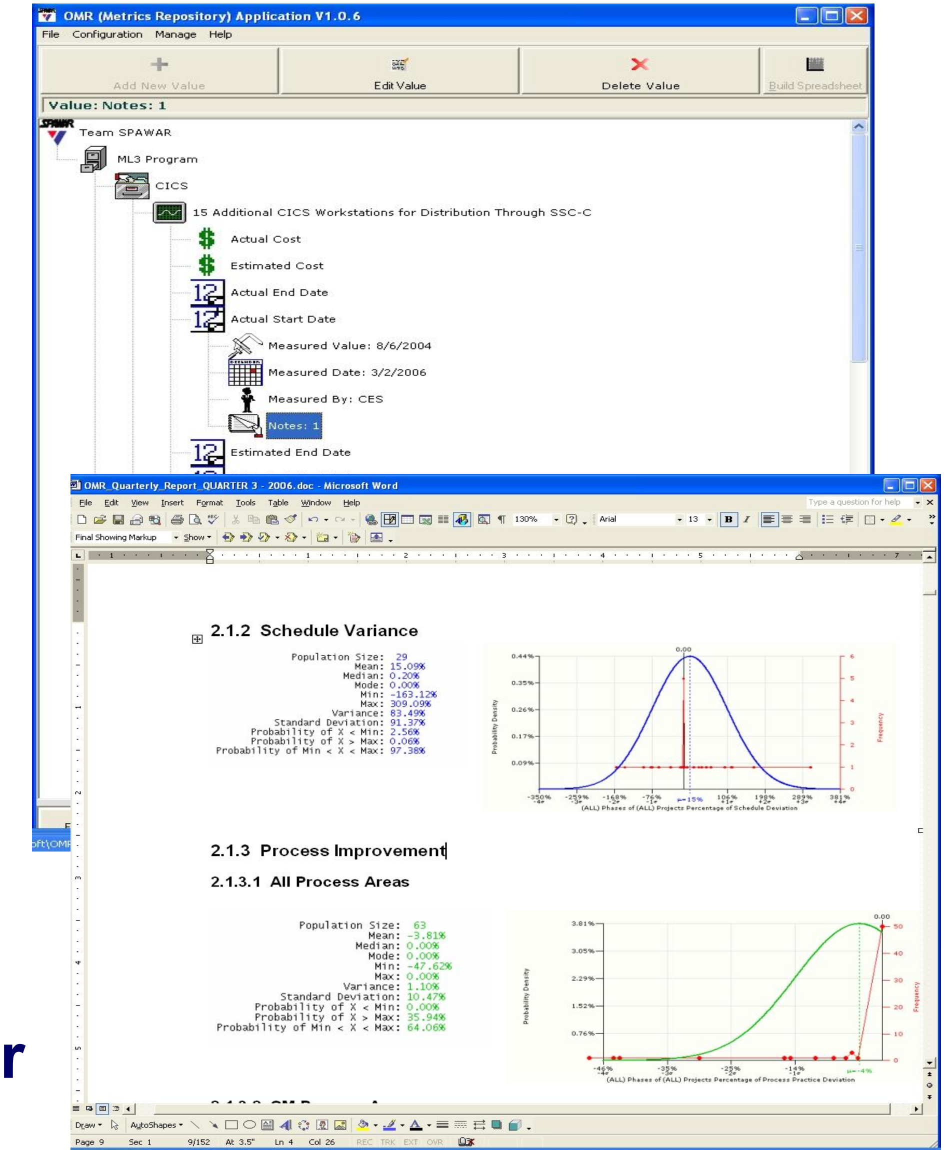
OMR Application

- ÅProvides interface for input and query functions
- ÅGenerates quarterly organizational report
- ÅProjects can use to manage own projects
  - ï Capture standardized cost, schedule, and process performance
- ÅOMR implementation included hands-on training
- ÅLaying the groundwork for higher maturity



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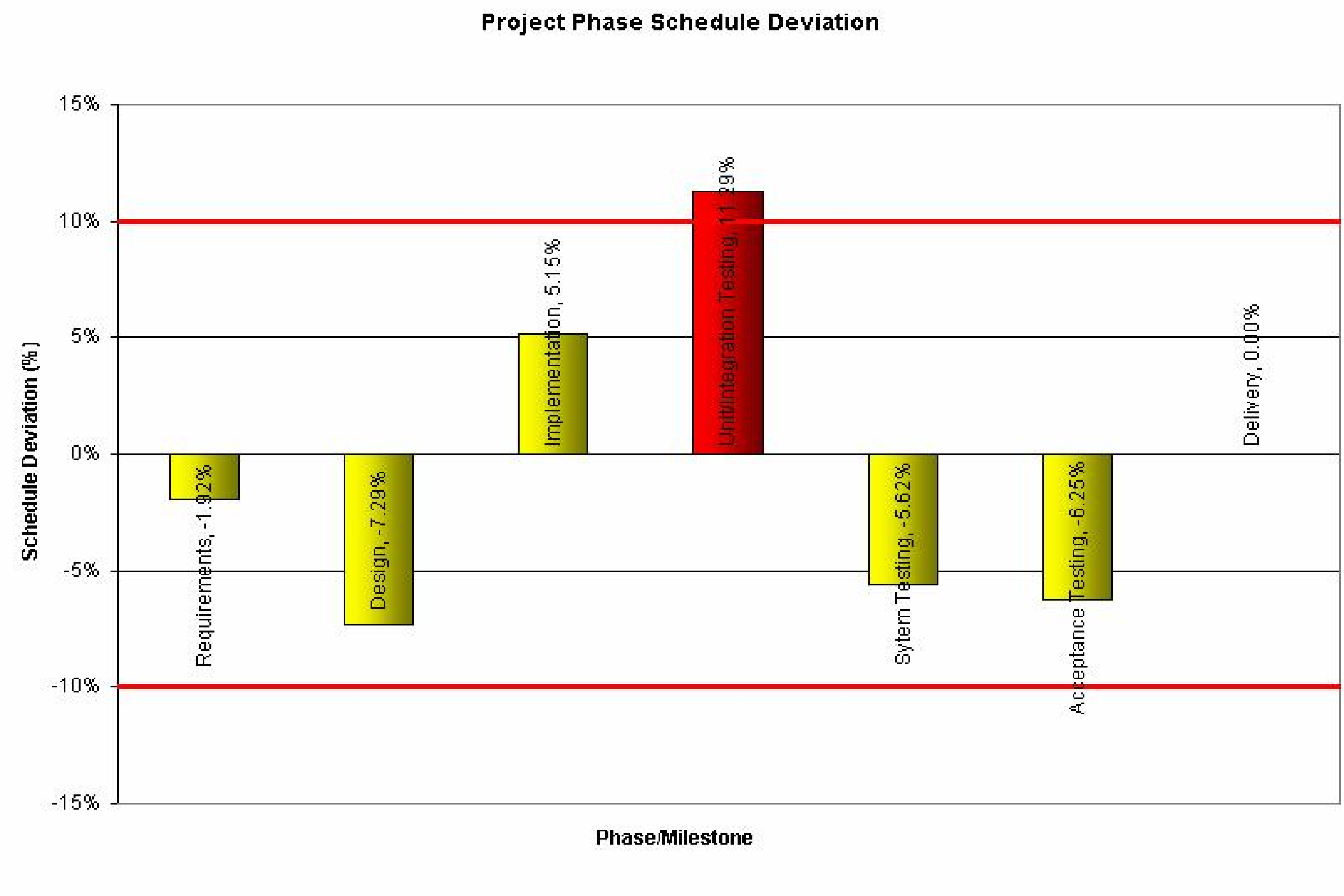
OMR Reports
Project-Level Schedule Deviation



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Additional/Modified Measures To Be Implemented in OMR

Category	Core Measure
Cost Performance (More granularity)	Å **Government vs Contractor budget** ï ODC ï Travel ï Training ï Materials
Quality	Å **Peer Reviews** ï Effectiveness ï ROI (hours expended vs hours saved) Å **Pre-Deployment Defect Detection/Prevention** ï Defect decrease for successive phases ï PITCO vs SOVT defects Å **Post-Deployment Defects**

Need improved project and organizational measures to address Maturity Level 4/5 requirements

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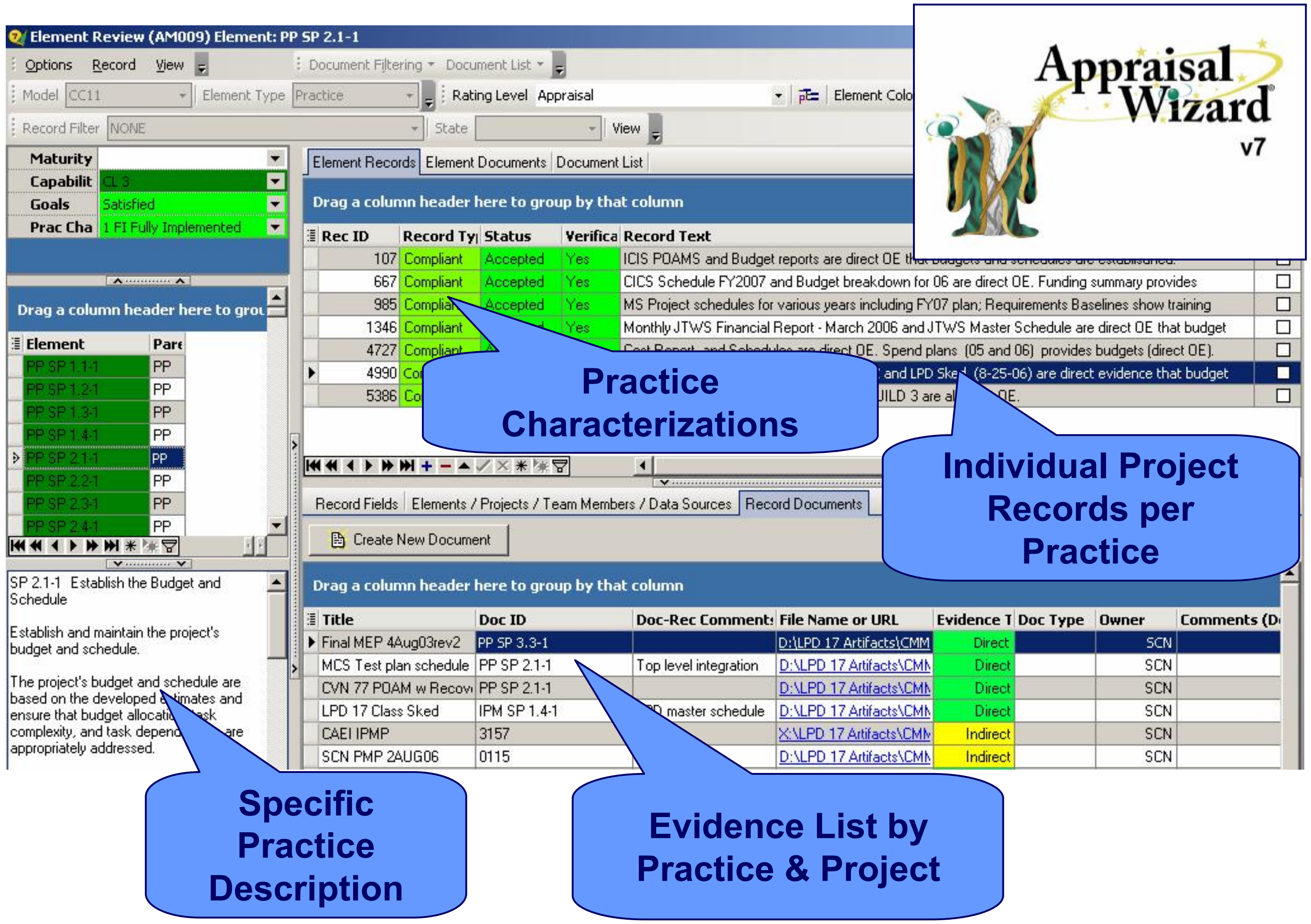
Appraisal Wizard Tool Used for SCAMPI Appraisals

- **Designed for CMMI appraisals**
- **Link to project documents**
- **Easy to configure**
- **Captures team comments**
- **Improves efficiency of appraisal team**



Appraisal Wizard is a product from Integrated Systems Diagnostics, Inc.
http://www.isd-inc.com

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Training

- Training Architecture
- Courses

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SE & PI Training Architecture

Foundation of PI and CMMI®

- PI WBT → SEI Intro to CMMI® 3-day

Core SSC-C project and engineering processes (Level 2 and 3)

- Engineering Project & Process Mgmt Workshop
- SE for Managers
- SEMP Workshop
- SE Fundamentals
- Intro to Software Engineering
- SE 101 WBT
- Architecture Dev. WBT
- Risk Management WBT

Subject Matter Experts - Use commercially available on-site classes

- Quality Engineering
- Risk Management
- Requirements Analysis

Prepare Projects for BSC or SCAMPI

- Appraisal & Assessment Workshop

Legend:

- Existing
- Existing - revise
- New - develop
- New - buy

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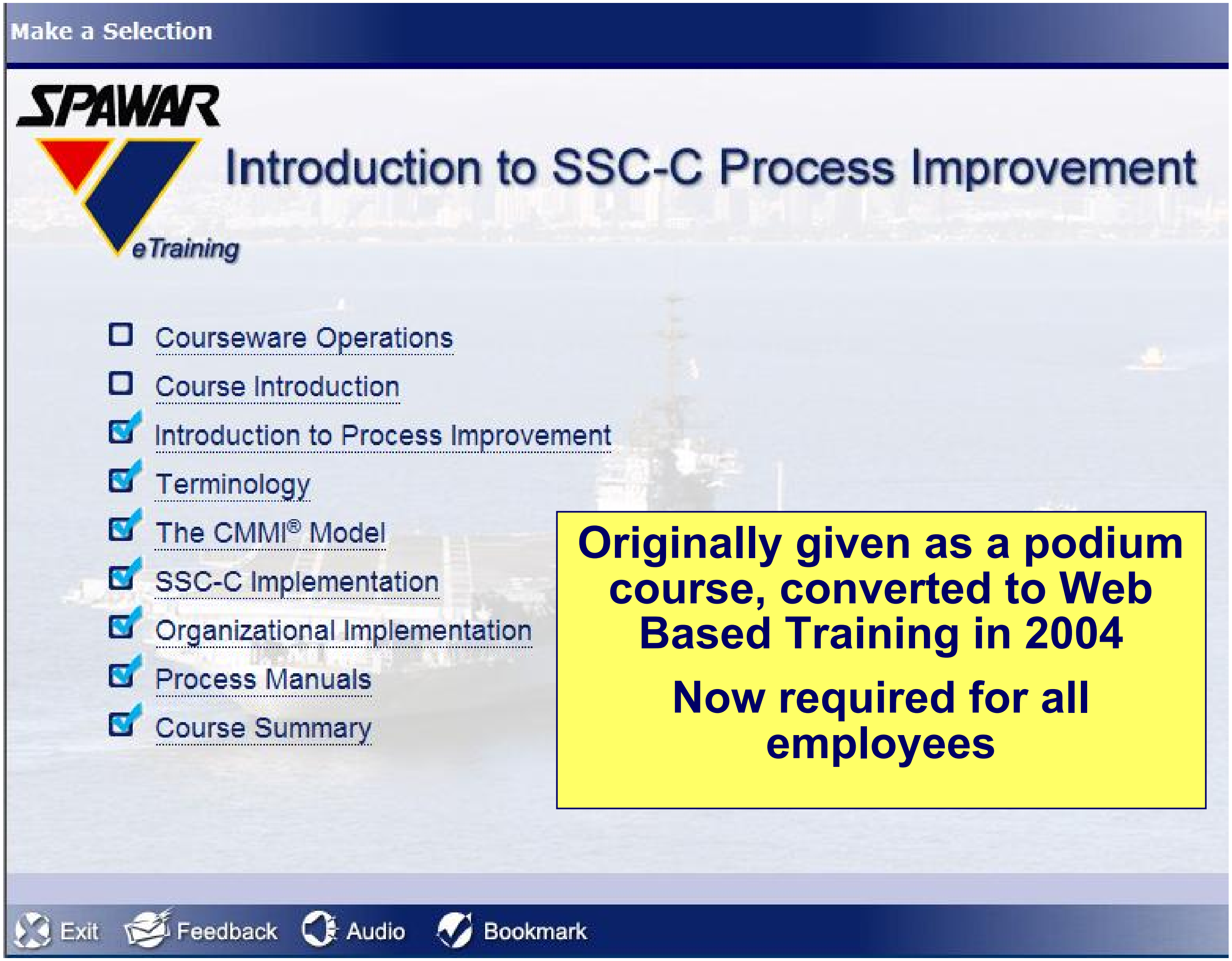
Intro to Process Improvement WBT



Originally given as a podium course, converted to Web Based Training in 2004

Now required for all employees

SEI Intro to CMMI® for SSC-C

Taught on-site since Apr. 2004

- **3-day *Introduction to CMMI®* course teaches the full CMMI® model**
  - Students learn how the best practices build and relate across process areas
  - Learn the terminology
- **SEI-Authorized instructors are well-versed in our implementation to augment material with SSC-C specific content**
  - Highlight SSC-C tools and resources
  - Actively involved in projects, teams, and infrastructure
- **Over 350 employees trained**
  - Want to build a cultural foundation within the engineering departments

Systems Engineering Training

3-day on-site, classroom course

- Based on SMU SE Masters course
- Customized to incorporate SSC-C SE process
- Over 340 SSC-C engineers trained

1-day SE for Managers course added

- Over 60 SSC-C managers trained

Began in Dec. 2004

"It was extremely beneficial to have a professor with extensive knowledge of the subject matter and one who could apply it to the SPAWAR methods."

"The most positive aspects I took from the class was the visual correlation with what was asked for and what was produced."

"I would recommend it to all the program leads/engineers."

Student Feedback

New On-Site Courses

- **Risk Management**
  - Piloted in September, 2007
    - 4-day course
  - Designed for Risk Managers or Project Managers
- **Engineering Project & Process Mgmt Workshop (aka SE Process Improvement)**
  - Focus on how to use the SSC-C processes on your project
    - Using ePlan Builder to develop plans
    - How to establish your CM and PPQA procedures
  - Round 2 of curriculum review completed in September
- **Quality Assurance (FY2008)**
  - Initial discussions held with ASQ certified instructor to tailor course for Quality Managers at the project level

b Based Training (WBT) Modules

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ÅDeveloped to directly meet SSC-C's needs

ï Embedded links directly to SSC-C documents and SOPs

ï DAU too ACAT-level/large program oriented

ÅWBTs feature extensive branching and rollovers

ï Better course flow and maintains interest

ï Provides more detail for those interested

ÅAudio summary on many pages

ÅBookmark progress – come back later

ÅCourses developed to be NMCI and 508 compliant

ï Utilize HTML, JavaScript, and ASP pages with SQL Server database

ï Designed for Internet Explorer (5.5 +), Flash (5.0 +), Windows Media Player (9.0 +)

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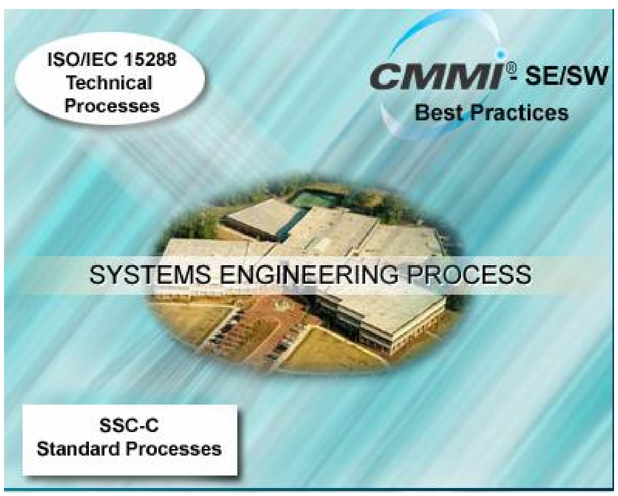
Introduction to Systems Engineering

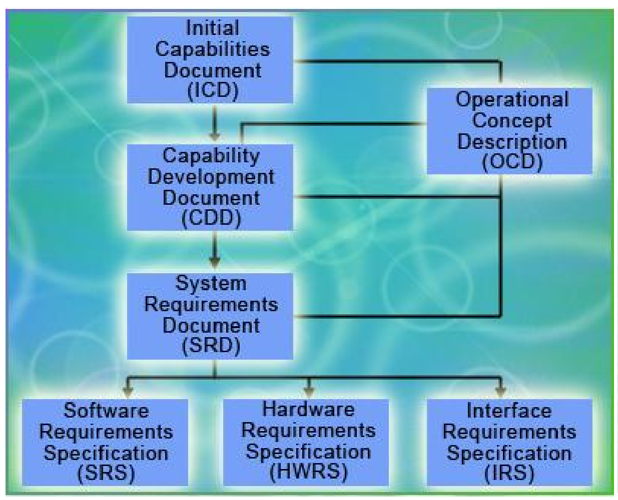
ï 10-module web-based training (~16 hours)

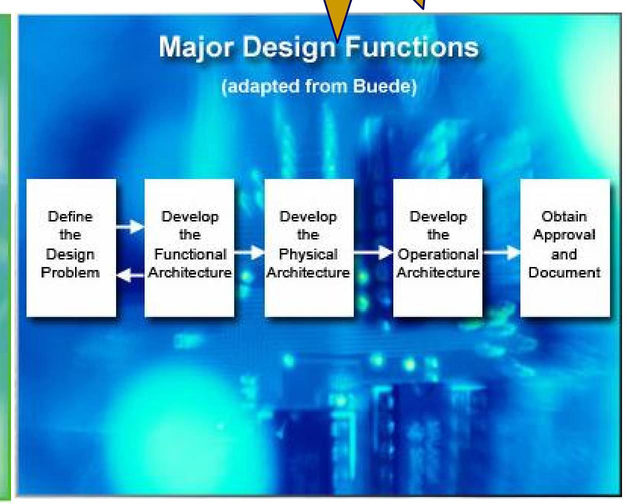
ï Closely aligned to SSC-C SE Process, SE Fundamentals Course, ISO/IEC 15288 and IEEE standards

ï Includes hotlinks to referenced documentation
  Å Process manuals, policies, standards
  Å Great for Topic-specific refresher training

Released in Jan. 2006







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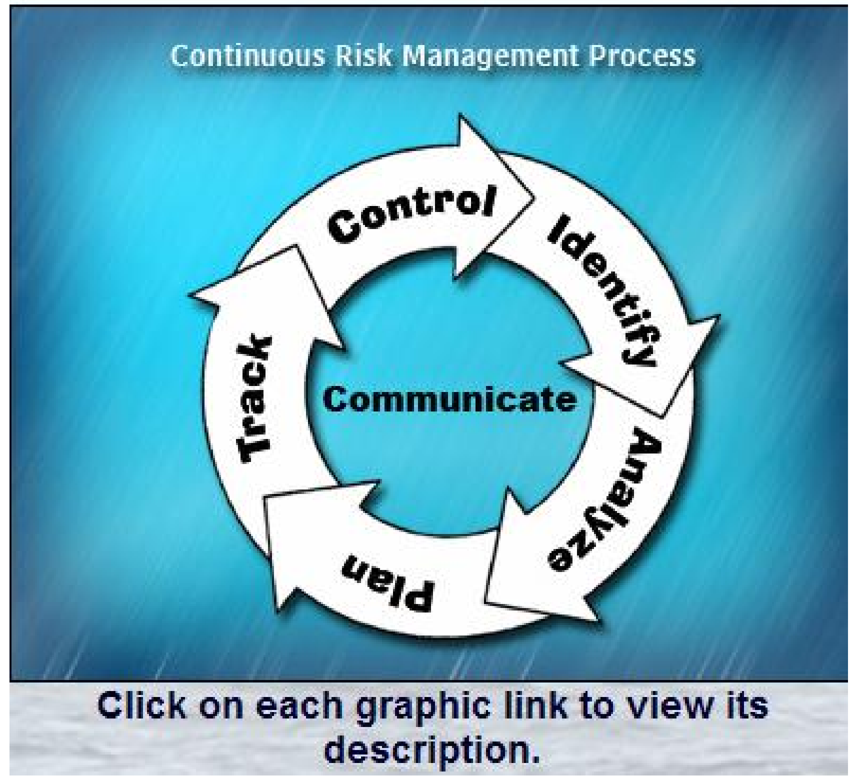
Risk Management WBT

- **Topics**
  - Risk identification
  - Analysis tools and techniques
  - Mitigation planning
  - Risk monitoring
- **Section Test Questions**
- **Hot Links to Examples**
  - SSC-C Formats
  - Project Risk Reports
  - Tools
  - DAU / External resources



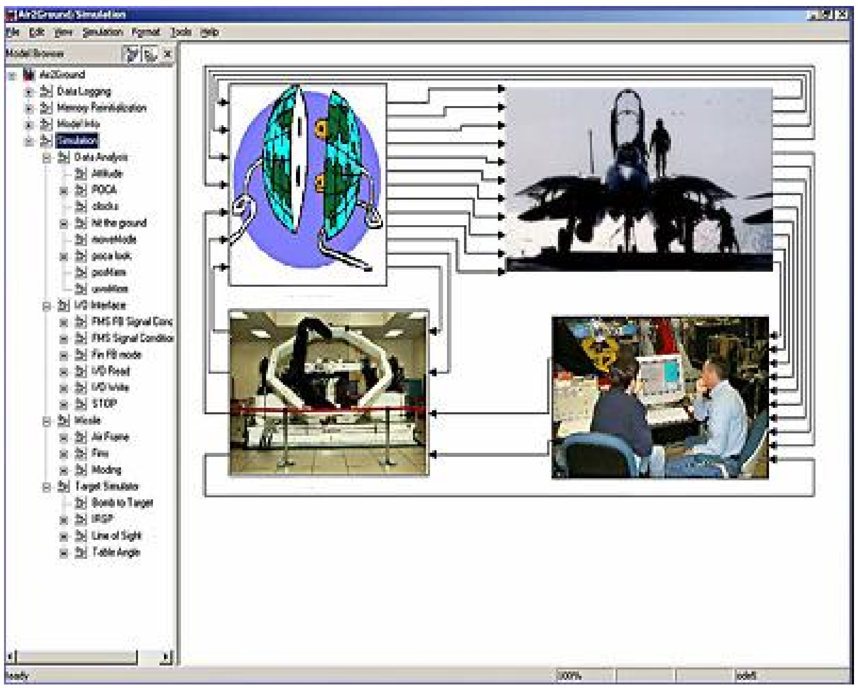
More relevant and understandable for SSC-C than the DAU module

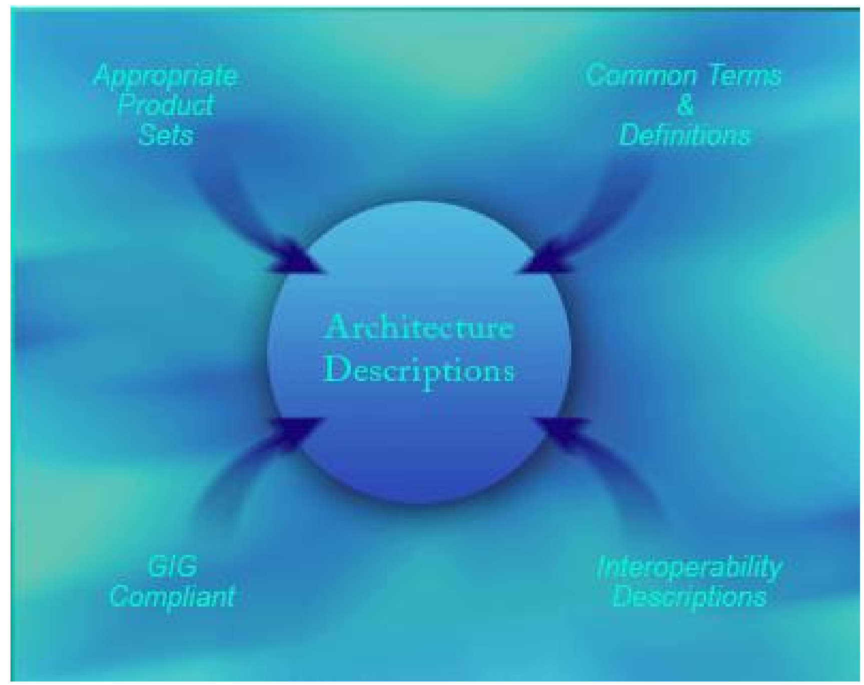
Architecture Development WBT

ÅIntroduction to Architecture Development and DoDAF

ï Designed to educate and promote value of system architecture to non-architects and new engineers

ï Tests for understanding after each section





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Summary and Results

N65236-ENGOPS-BRIEF-0048-1.2

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What We Have Accomplished

- **Process Focus**
  - Defined Policies and Processes
  - Aligned with DoD and SPAWAR guidance
  - Aligned with industry standards and CMMI® model
  - Built organization structured around processes and process improvement
- **Training is Critical**
  - Providing Fundamentals of Engineering for new and old professionals
  - Developed web-based training for "self-paced" and refresher training
  - Defining a structured technical career development path for engineers
- **Tools for the Engineers**
  - Developed *ePlan Builder* application to generate planning documents
  - Developed templates, checklists, and web-based document repositories to link standards and DoD guidance to day-to-day tasks and processes

Early and persistent Systems and Software Engineering applied to programs and projects

Lessons Learned

- **Senior Management support is critical to success**
- **Training**
  - Everyone needs to be engaged – "train the masses"
  - Specific training for process owners/subject matter experts
- **Utilize Teams (IPTs) as champions of specific processes**
  - Multi-department representation
  - Change agent mentality
  - Process-focused charters
- **Resource Properly**
  - Implement with projects that want to improve, can benefit from efforts, and that recognize own weaknesses
  - EPO staff provided skilled coaching, resources, support, and tools
  - Project members learned by doing and maintaining
- **Goals and Publicity**
  - Keep goals to sizable bites (projects)
  - Publicize successes; Share best practices

Is the SE Revitalization Working ?

Recognition of SE and CMMI effort

- 1st SPAWAR Systems Center to achieve Maturity Level 2 (2005)
- 1st SPAWAR Systems Center to achieve Maturity Level 3 (2007)
- Multiple presenter at NDIA SE and CMMI conferences
  - High interest in Tools, Training, and Implementation

Is the SE Revitalization Working ?

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ÅBusiness Results

- ï SCN: ñThey see us as a model and want to increase our efforts.ò
- ï Automation Program: ñWe had hundreds of sites and there was a need for a structured organization to put a ówrapperô around that and control it. CMMI became the wrapper.ò
- ï CICS: ñCMMI was key to achieving the project goal.ò
- ï VIDS: ñThe VIDS failure (2000) motivated implementing CMMI because the team needed to change course or the customer would have no confidence in system development. It was a tremendous successé ò

ÅOthers Asking for Help

- ï PMS 408 ï CREW program
- ï SESG / NAVAIR / NAVSEA
- ï Marine Corp ï Quantico
- ï Air Armament Center, Eglin AFB

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Going Forward

- Increase usage of tools across departments/projects
- Add additional plans to ePlan Builder as needed
- Continue internal CMMI Level 3 mini assessments
- Enhance/Expand OMR
- Command and Department Project Reviews process
  - Look at quality of plans and implementation of best practices
  - Reviews of project status by management driven by project metrics
  - More Peer Reviews to measure "saves"
- Better tailoring guidance for smaller projects

Begin Maturity Level 4/5 implementation

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Any Questions?

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Phone: 843-218-5706

Mike Knox
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Email: mjknox@techsoft.com
Phone: 850-469-0086

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Project Management by Functional Capability

NDIA CMMI Technology Conference and User's Group November 15, 2007

Software Engineering Institute
Carnegie Mellon

Fred Schenker
Software Engineering Institute

CSCI

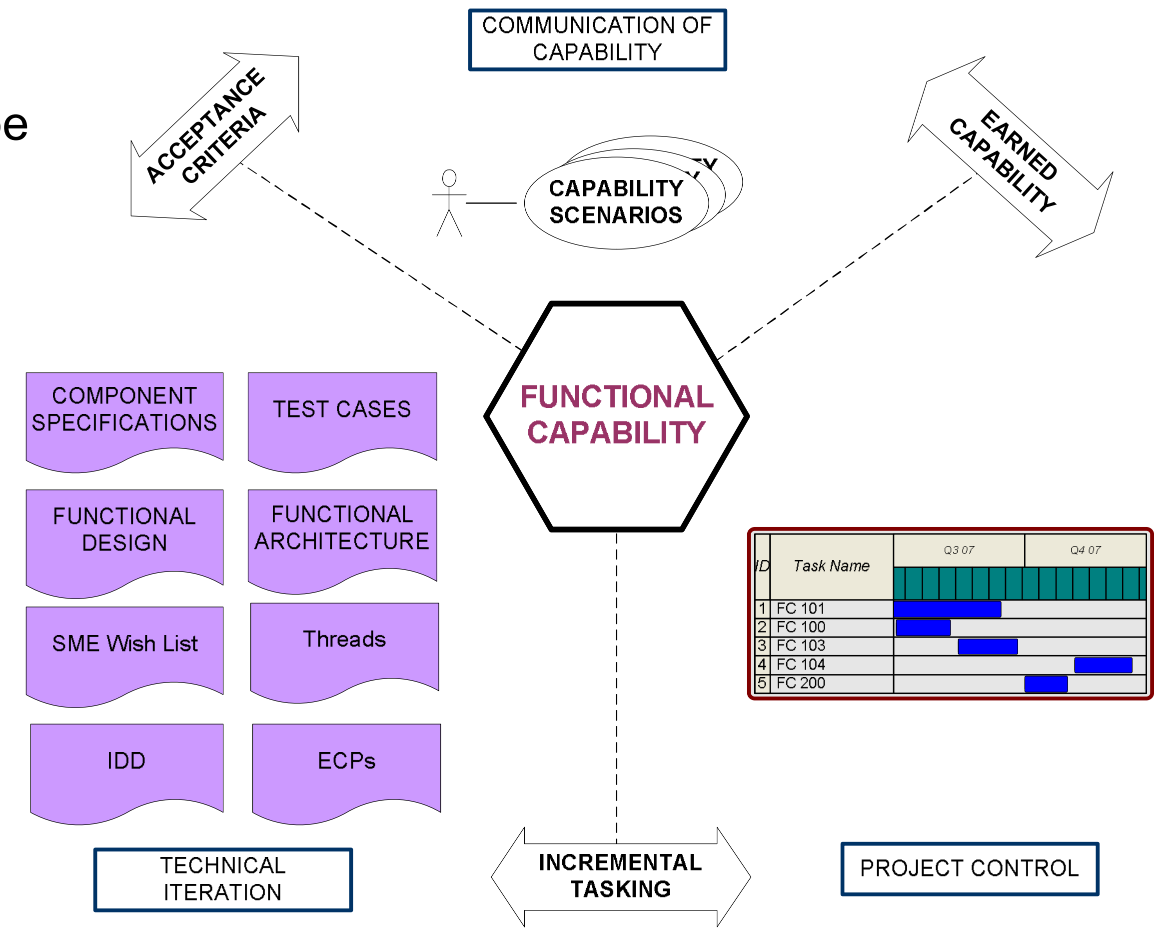
Bob Jacobs
Computer Systems Center Inc.

resentation

- To introduce Functional Capabilities (FCs) as a “useful” mechanism for managing work in a complex product development environment
  – An efficient way to communicate functionality to the user, the developer, and other stakeholders
  – A structure of discrete artifacts and flows that define product development lifecycle activities
    - logical design
    - system analysis, design and implementation
    - testing
  – A scheme for planning, tasking, and tracking work
  – An effective generator of artifacts for CMMI
- To share experiences gained from initial deployment of this project management process

ability – Context

- Consider your *Program* to be a large amount of *functionality,* expressed as *capabilities*
- *Functional* decomposition will provide increments of work to be accomplished, resulting in incremental *capability*
- We are proposing *functional capabilities* as a project management scheme to help deliver:
  - the right product
  - delivered on time and within budget



- Problem Statement
- SIAP
- Program Performance
- Functional Capability Overview
- Functional Capability Elaboration
- CMMI Mapping
- Summary

nent

- Product developers routinely fail to execute their projects
  - GAO Report 05/301, 2005
  - Defense Acquisition Performance Assessment, 2006
- How do acquirers gain insight into their project's performance?
  - Does developer CMMI ML significantly affect project performance? If not, why not?
- How do contractors know they are producing what their customer wants?
- Do we need a different project context for Systems of Systems (SoS)?
  - CMU/SEI-2006-TR-017, Systems of Systems: "Scaling Up the Development Process"

munication of Capability

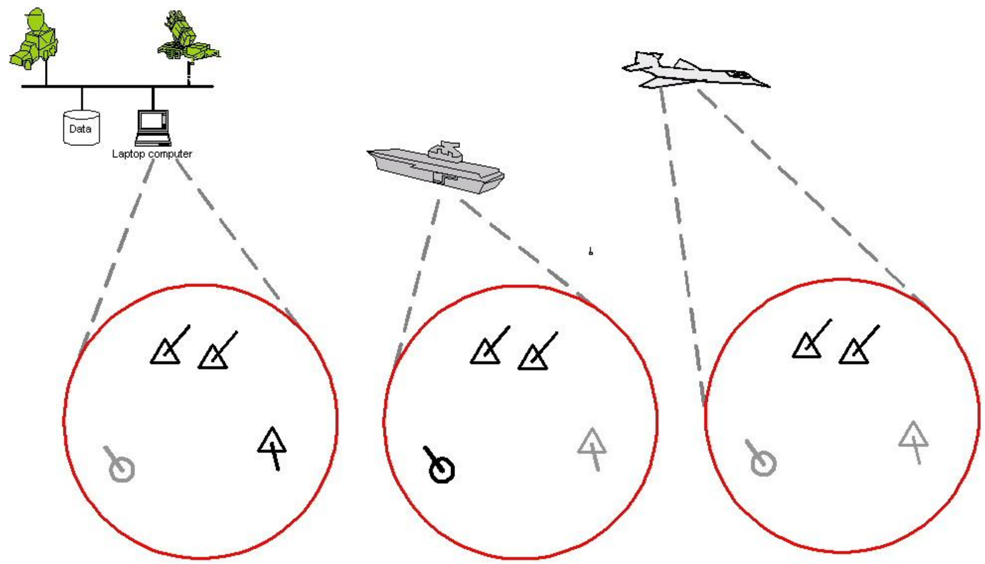
- Capability must be expressed in user terms... What they want
  - Joint Capabilities Integration and Development System (JCIDS) is not sufficient
  - systems engineers need more expressive methods for requirements capture and development
- What they will get
  - "System" specifications (to drive developers) that users can relate directly to capabilities
- And how they know they are getting it
  - Earned value expressed in terms of capability, i.e., "earned capability"
    - performance-based earned value
    - assessment of functionality bow wave

Development Practices

- SoS: Collaborating systems developed by collaborating system acquisition teams
  - highly autonomous systems and teams
- Process challenges in:
  - organizational ownership, responsibilities, and technical team interactions
  - systems:
    - boundary definition
    - legacy systems and continuous technology evolution
    - continuous capability evolution
  - project definition, measurement, and reporting mechanisms
  - project execution processes
- Practical process methods are needed

ingle Integrated Air Picture

- FCs developed from experiences in SIAP
  - SIAP is a Software Intensive System
  - FCs should apply to SoS in general

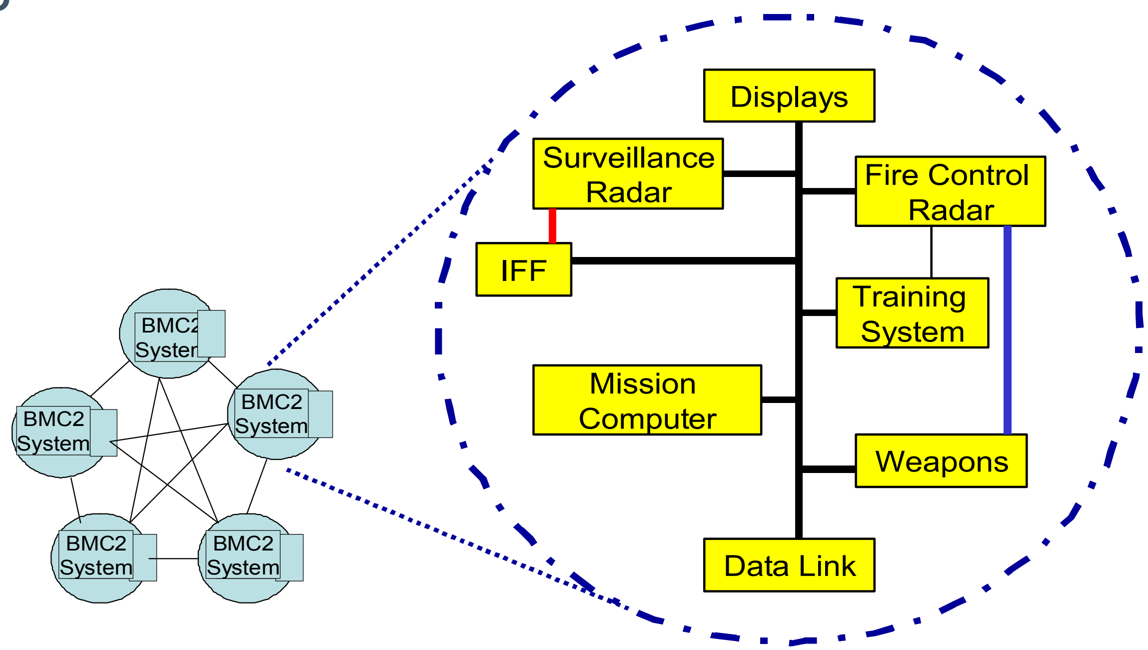


- SIAP Capability
  - **user viewpoint:** common, correct, complete, continuous, timely track situation presentation
  - **system viewpoint:** state of data consistency among distributed, replicated data stores, for objects of peer interest

DISCLAIMER: This presentation makes no statement concerning current SIAP engineering practices.

ity Material Challenge

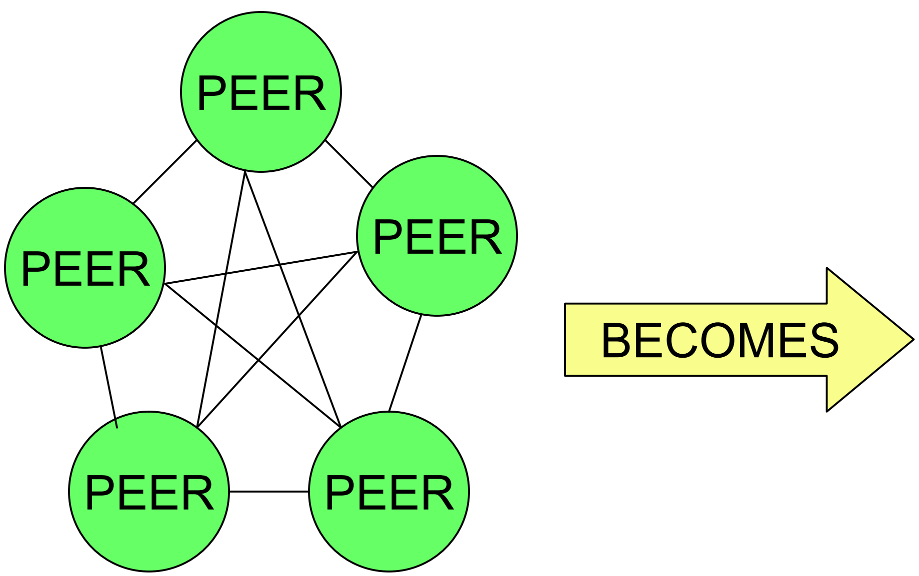
- SIAP requires interactions of networked peers, each an operational node hosting multiple integrated systems
- Network connections are weak, with ad hoc, dynamic configurations



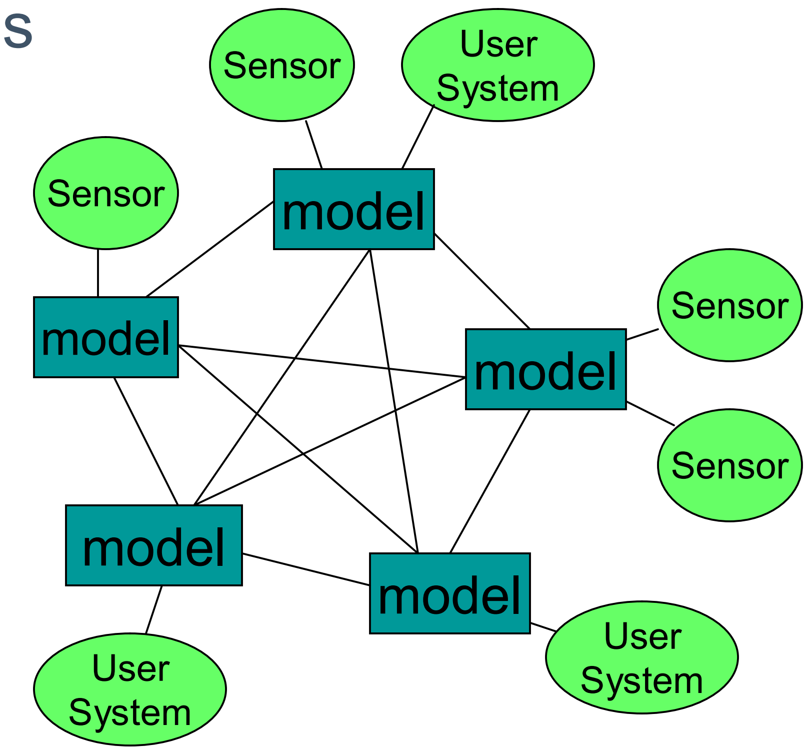
ity Material Solution

– Executable Object Model transformable to code, with core required functionality

– Agile-development processes



Unpredictable Heterogeneous Set of Systems



Predictable, Logically Homogeneous Federation

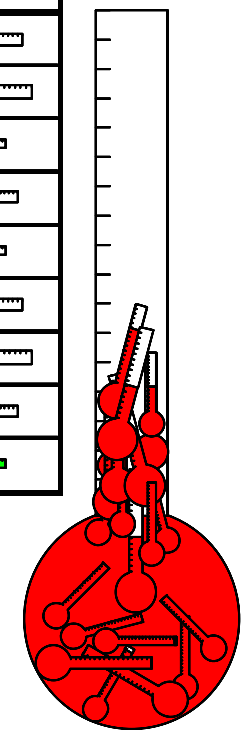
f Capability

- Functional Capabilities express *functional* requirements
  - manageable abstraction level for SoS
  - meaningful to user and developer
- An FC identifies a value-chain
  - tangible artifacts
  - framework for measuring program process performance
- An FC represents value that can be earned against a planned-performance baseline
  - an example of Performance-Based Earned Value®

ability – Earned Capability (Value)

FC #	Description	# Req	# Use Cases	# Scenarios	# IPT Affected	Pol. Vis.	Total	Status
FC 1		5	3	1	1	Hot	26	
FC 2		49	8	3	3	Hot Hot	88	
FC 2.1		18	2	2	1	Hot	24	
FC 2.2		22	4	1	1	Hot Hot	34	
FC 2.3		9	2	3	2	Medium	14	
FC 3		13	6	2	2	Medium	39	
FC 4		45	9	4	3	Hot	81	
FC 4.1		33	6	2	2	Hot	46	
FC 4.2		12	3	2	1	Medium	22	

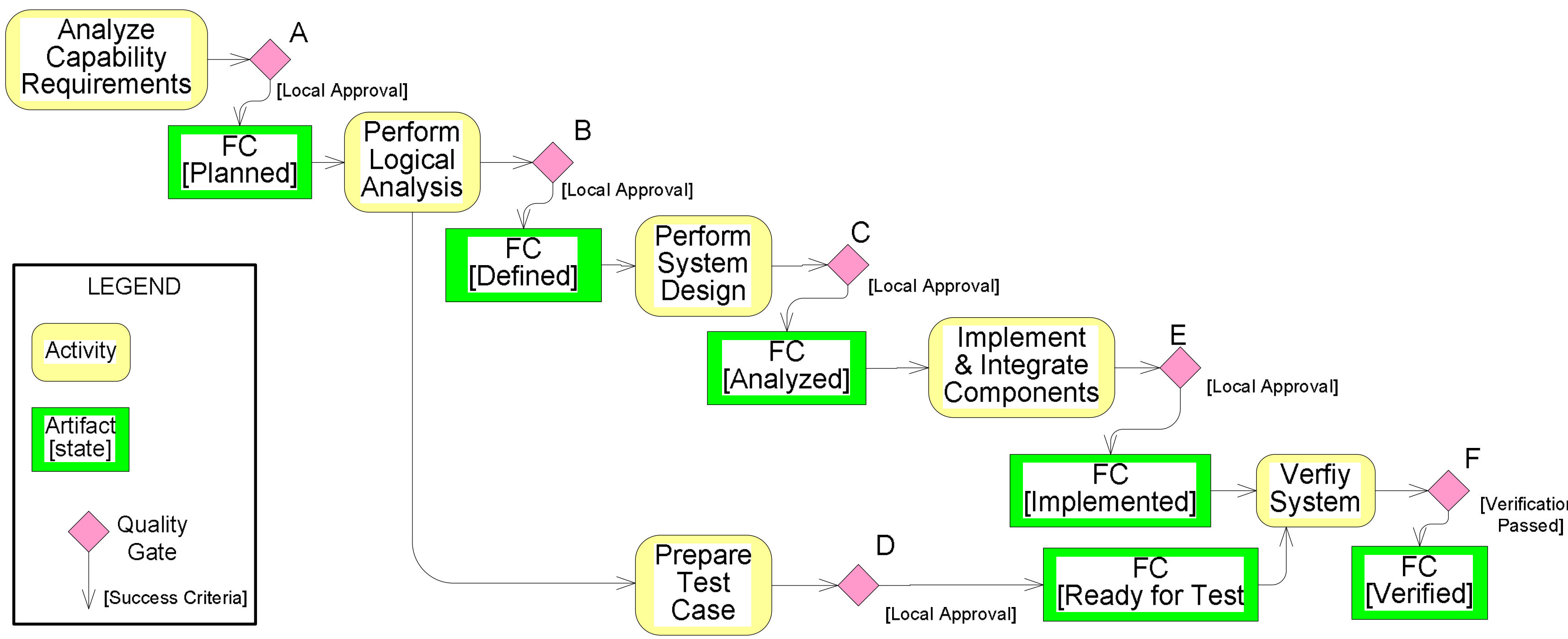
- Establish relative size measures for each capability
- Establish dependencies between capability projects
- Establish the approved list of capability (or value)
- Release work as appropriate and accrue "value" against the project capability "baseline" at Management reviews
- Measure project lifecycle task duration and effort to refine estimation process and establish project historical parametric data
- Capability can be "re-scoped", but deviations from the baseline are easily recognizable as the "bow-wave" of functionality



Capabil-o-meter

ability Life Cycle

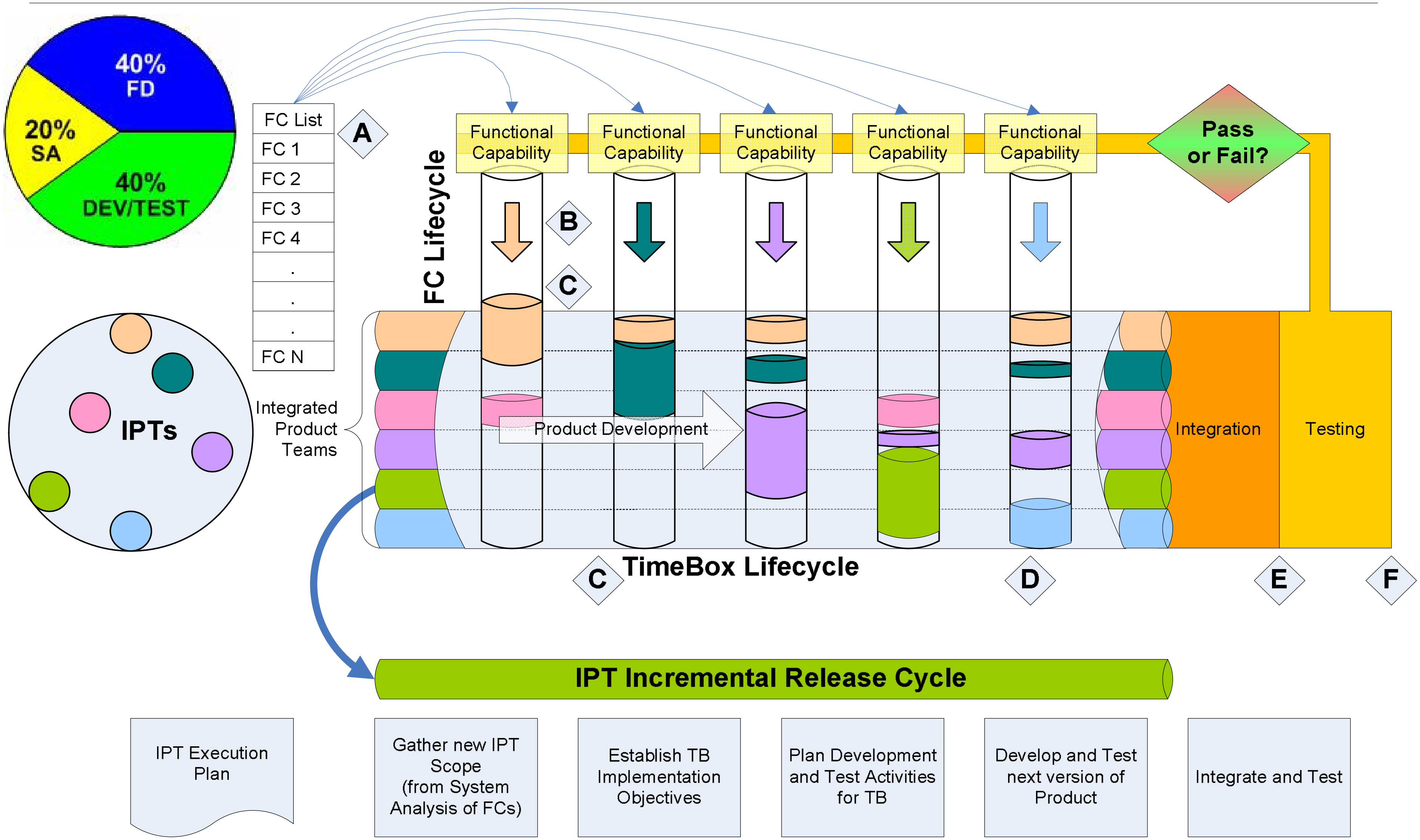
- Each FC advances through lifecycle phases, representing states of completion, defined by artifacts
- Artifacts are reviewed at Quality gates, providing evidence of value



d Value

ARTIFACTS:	FC [Planned] Funtional Capability Planning Definition	FC [Designed] Functional Capabilities Description Document	FC [Analyzed] Component Development Specifications	FC [Implemented] Working Software (e.g., xUML model)	FC [Verified] Tested SOS
	Quality Check	Quality Check	Quality Check	Quality Check	Quality Check
USED FOR:	Planning Basis of Estimate, WBS	System Analysis and Design	Development Team Work Packages	Unit & Integration Testing	Verification (& demo/sim)
IMPACT:	System Functional Requirements Baseline	Incremental Functional Baseline by FC	Incremental Allocated Baseline by FC	Incremental Component Product	Incremental End-Item Capability
VALUE ACCRUED:	Earned Capability Baseline	text	text	text	text

ability – Overview



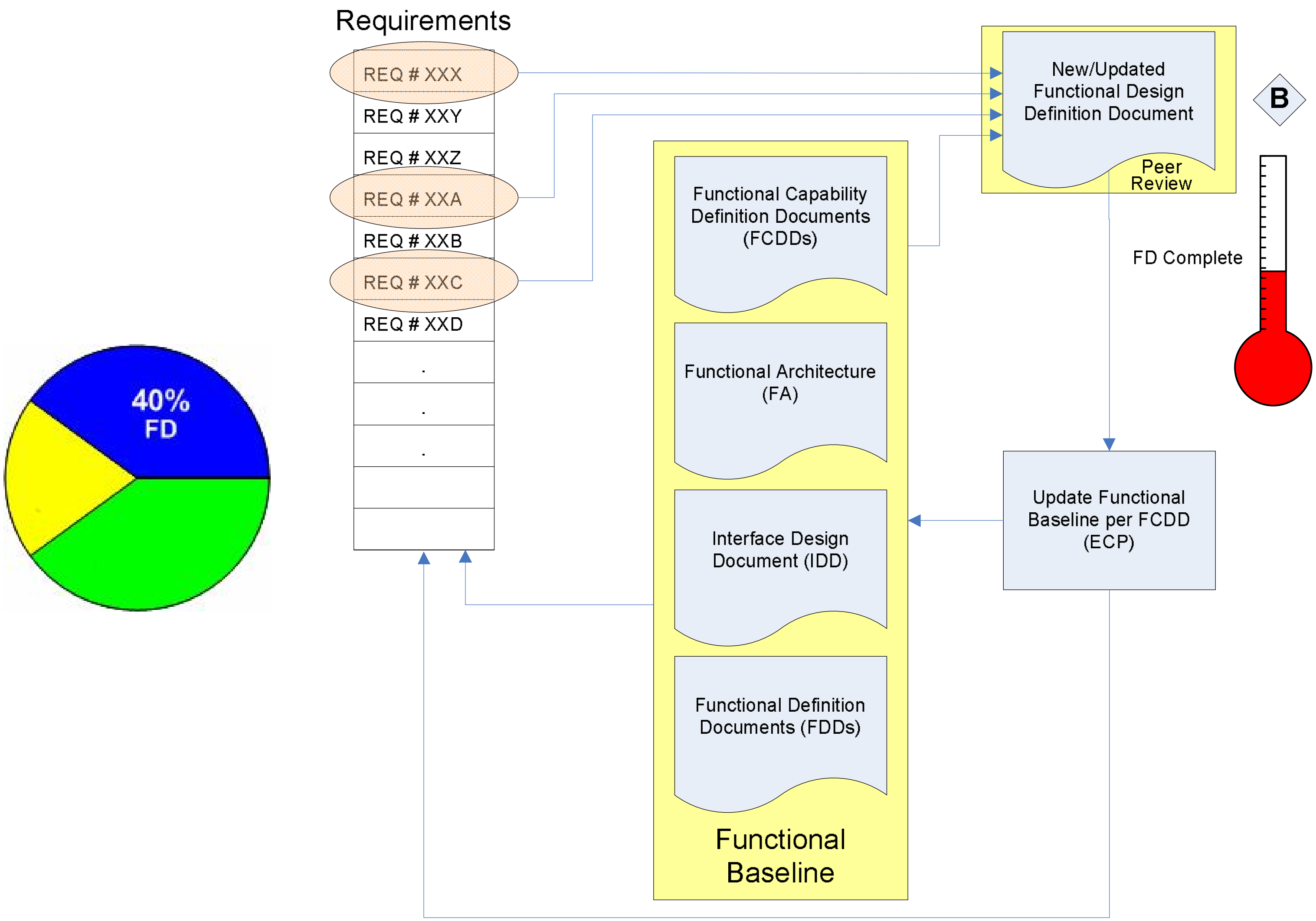
…ability – Planning Definition

- Early in the Program Lifecycle, Functional Capability planning definitions are needed:
  - Based on End-to-End mission scenarios
  - No more than one or two pages per FC
  - Preliminary allocation of requirements
  - High-level textual description
  - Basis of estimates for effort, resource, and schedule planning (use cases, complexity, requirements, etc.)
  - Use historical data where possible (and practical)
  - Establish FC priority and FC-FC dependencies
- Use the planning definitions to establish Earned Capability baseline and to scope project deliverables and dates

ability – Functional Definition

- Refine the scenarios to specify the capabilities
- Finalize allocation of functional requirements to the notional FC
- Elaborate the FC
  - Create a contextual description of the functionality
  - Create sequence diagrams, use cases, behavior diagrams
  - Ensure the allocated requirements are explained adequately in the context of the functionality
  - Provide criteria for FC acceptance
- Validate the FC
  - Peer review
  - Customer review
  - Management review (Q-Gate)

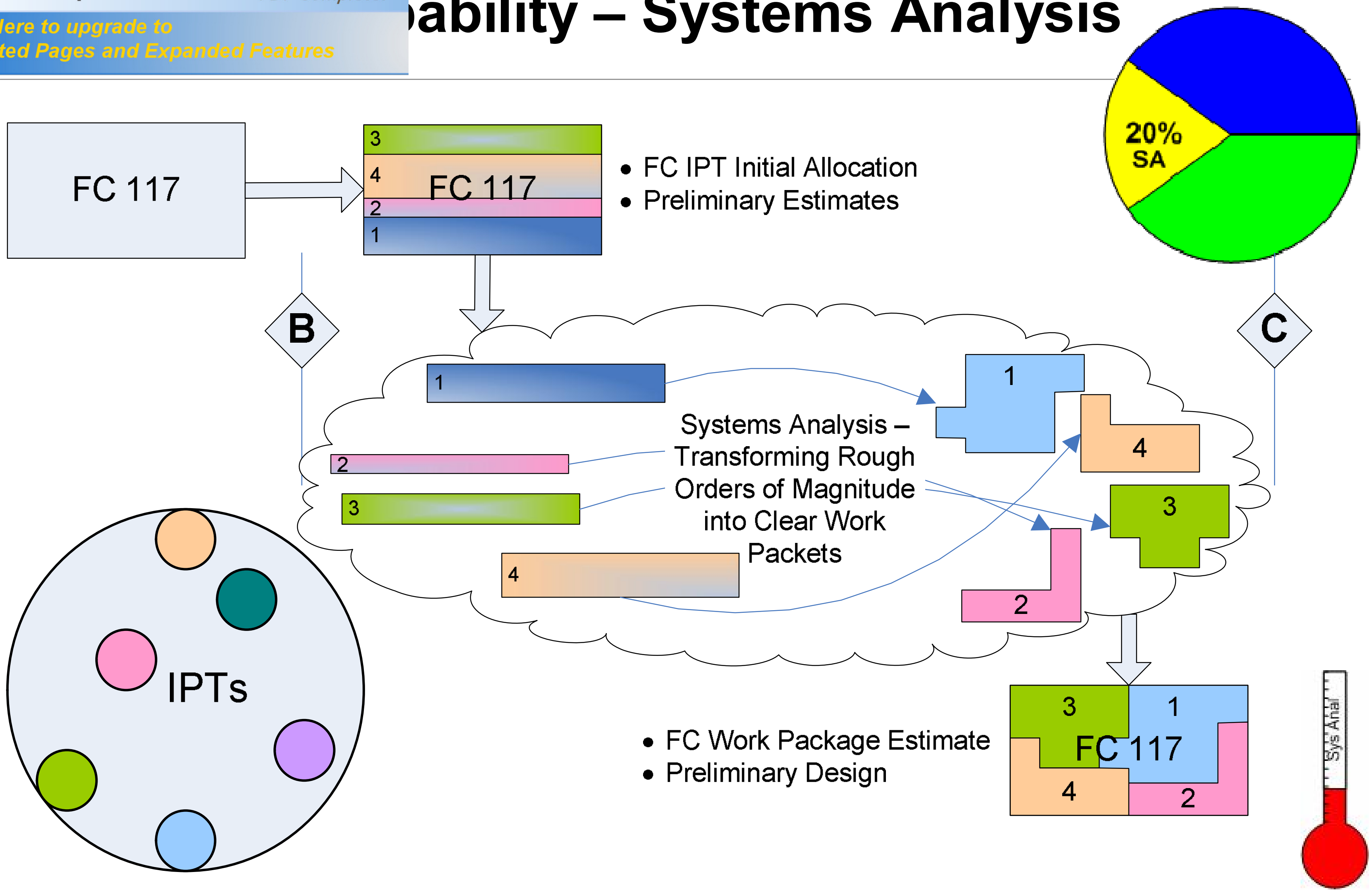
ability – Functional Definition



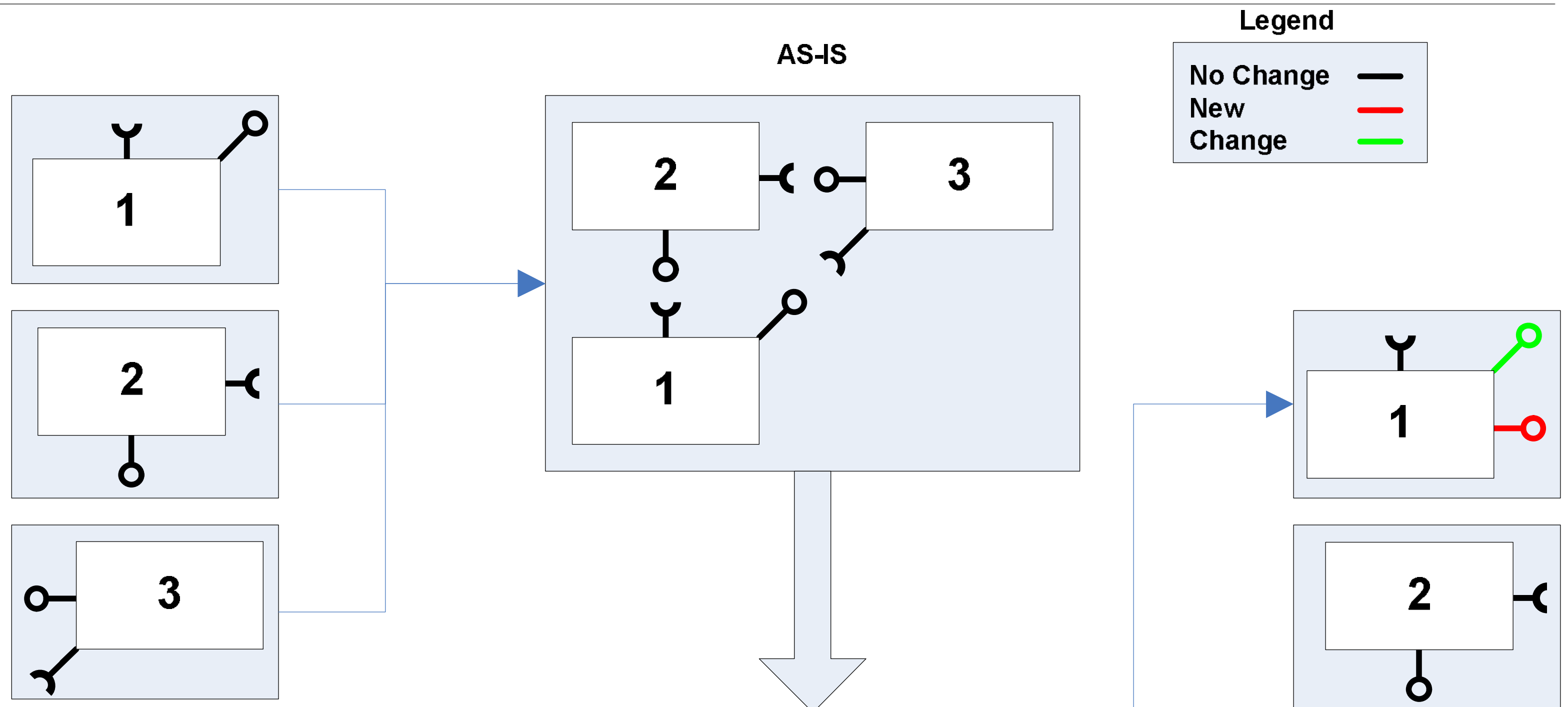
ability – Systems Analysis

- Start with validated functional design
- Allocate functionality to legacy components
  - Identify and analyze design alternatives as necessary, especially for risk mitigation
  - Update existing / create new design documentation, component specifications
  - Create work packages to implement the new designs
  - Update previous estimates of effort and schedule
  - Identify task dependencies, establish need for commitments for inter-component deliverables
- Validate the Analysis
  - Peer review
  - Customer review
  - Management review (Q-Gate)

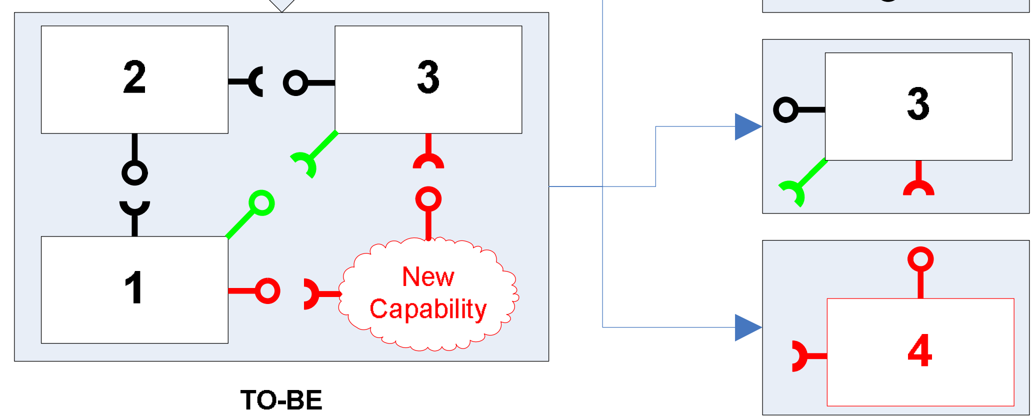
ability – Systems Analysis



ability – Systems Analysis



Para. #	Title	Affected Area	Type of Change	Work Ref. #
1.1				
1.2				
1.3				
2.1				



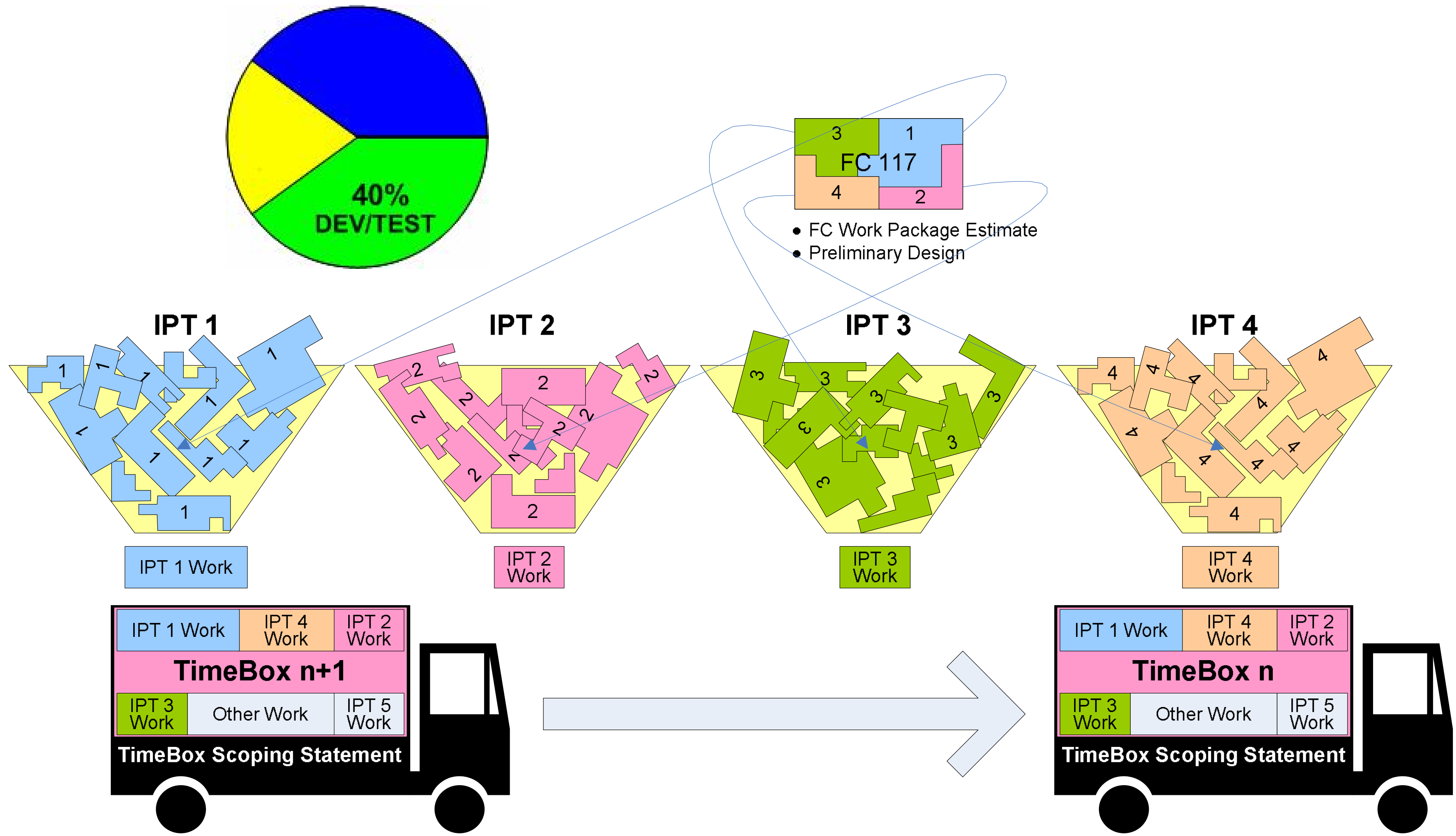
ability – Test Preparation

- Start with Functional Capability Definition Document requirements acceptance criteria
  - Review the acceptance criteria
    - New scenarios that need to be instantiated
    - New requirements that need to be verified
    - Legacy requirements that have been further clarified
  - Develop/modify test cases based on the criteria
  - If necessary, create new scenario (data set)
  - Identify need for additional test tools, and develop those tools
- Validate the Test Preparation
  - Peer review test cases and scenarios
  - Management review (Q-Gate)

...ability – Dev. & Int.

- Start with validated System Analysis
- Coordinate the tasks so that the Functional Capability is achieved
  - Identify and negotiate commitments between development teams
  - Establish development goals for the next increment of production (TimeBox)
  - Execute tasks in accordance with the plan
  - Perform verification tasks and pass on to integration
- Integrate the new products
  - Check interfaces, build new integrated product
  - Verify new build (smoke test)
- Validate the Development and Integration
  - Management Review (Q-Gate)

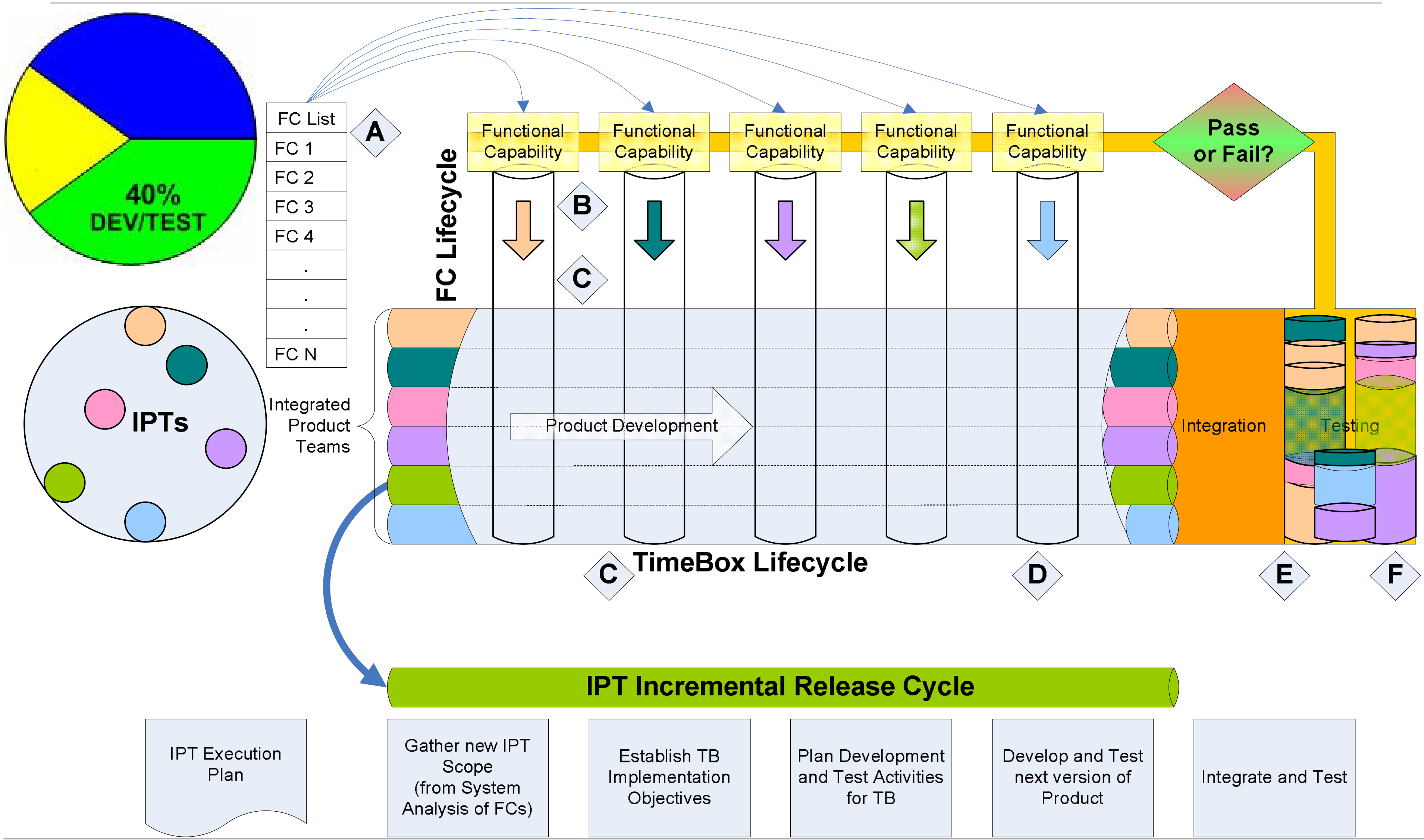
ability – Dev. & Int.



...ability – System Test

- Start with stable production build
  - Regression test (with new test cases)
  - Log bugs/defects
  - Perform SoS simulated testing (if possible)
  - Evaluate performance bottlenecks; potential SoS issues
  - Produce test report
- Validate the results
  - Management review (Q-gate)

...ability – System Test



CMMI

Q: So what does this have to with CMMI anyway?

This is the CMMI User's Conference, right?

A1: If you adopt the Functional Capability lifecycle, you get a lot of CMMI credit…

A2: If you managed your projects this way you could use CMMI practices (esp. M&A) to help you

- Produce what your customers want
- Make sure your contractor is performing

abilities – CMMI Mapping 1

- Project Planning (SG 1, SG 2, SG 3)
  - Estimation of FC scope (size, complexity, effort, priority)
  - Standard FC WBS
  - Defined FC lifecycle
  - FC implementation risks
  - Stakeholder identification and involvement (FC prioritization)
  - FC Implementation Budget and Schedule (FC Owners ≈ CAMs)
  - Summation of FC Planning Definitions (Baseline Plan)
  - Commitments established between IPTs
- Project Monitoring and Control (SG 1)
  - Defined project milestones (Q-Gates)
  - “Earned” Capability to calibrate program performance

…abilities – CMMI Mapping 2

- Requirements Development (SG 1, SG 2, SG 3)
  - Stakeholder “needs” documented (or referenced) in FCDD, and validated via peer review
  - Context for requirement implementation and acceptance criteria provided in FCDD
    - Basis for product component and interface requirements
    - Definition of required functionality
    - Basis for requirements validation
  - Use cases documented in the FCDD (Operational concepts and scenarios)
- Technical Solution (SG 1, SG 2, SG 3)
  - Alternative solutions documented in FCDD and propagated through System Analysis of FC
  - FCDD represents documentation of Functional design

…abilities – CMMI Mapping 3

- Requirements Management (SG 1)
  - FCDD helps to develop an understanding of requirements
  - FCDD to Requirements trace useful for identifying impact of changes
- Verification (SG 1, SG 2, SG 3)
  - Requirements Verification acceptance criteria defined in FCDD
  - Defined artifacts represent obvious opportunities for Peer Review
- Validation (SG 1, SG 2)
  - Defined artifacts are used to interpret, communicate and validate product design
  - Product lifecycle defines artifacts, essential for planning validation activities

abilities – CMMI Mapping 4

- Integrated Project Management (SG 2)
  – FC Definition Document provides basis for management of stakeholder involvement, dependencies, and identification (and resolution) of coordination issues
- Measurement and Analysis (SG 1, SG 2)
  – FC baseline represents program commitment
  – Tracking of FC progress connects tasks execution to management information needs
- Quantitative Project Management (SG 1, SG 2)
  – FC baseline represents the program’s performance objective
  – Tracking of FC progress helps to determine whether the program’s objectives for performance are being satisfied, and are used to identify appropriate corrective actions

- Functional Capability provides a useful framework for managing projects
  - In a complex environment (SoS)
  - As a significant contributor of value-adding artifacts
  - As a starting point for introducing quantitative methods into the project management process
  - As a means of communicating capability, both desired and earned
  - As an effective means to deliver relevant technical and project management content to external stakeholders
  - As a method of assessing the “bow-wave” on a project, and calibrating the reported earned value

Thank you for your attention!!

ation

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Applying CMMI Principles to the Military Certification Process of Legacy Aircraft

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The Boeing Company

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610-591-6949

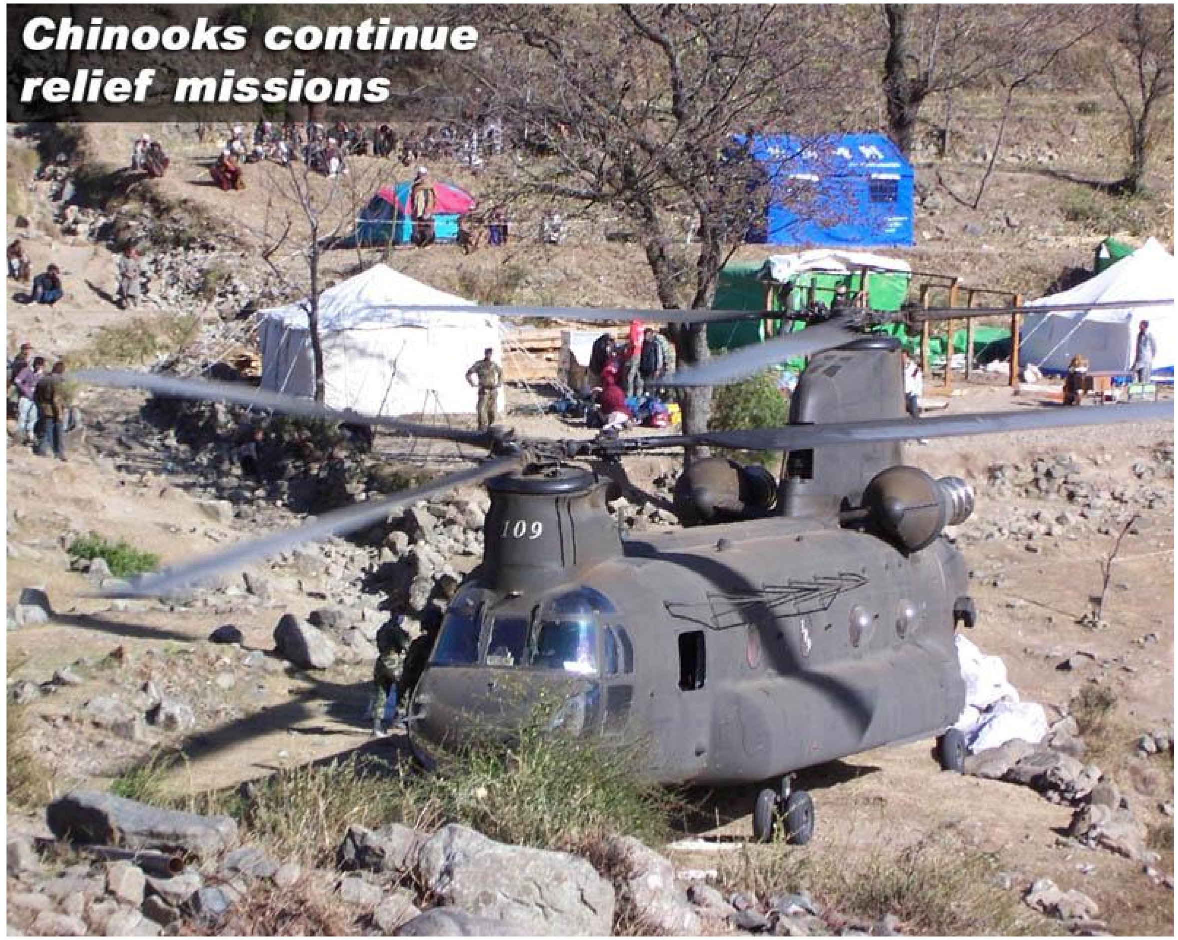
ntroduction

- First introduced in 1962
  - Deployed in Vietnam
- Multi-mission, heavy-lift transport
- 1,179 Chinooks Worldwide
- Service life projected beyond 2030
- Strong International Demand
  - Civil and military applications

perations

CH-47 ★ Team Chinook

- Ability to land on unprepared ground



perations

CH-47 ★ Team Chinook

- Heavy Lift Capability
- Lifting capacity of 21,500-pounds

n Introduction

CH-47 ★ Team Chinook

- A demonstrated capability of an aircraft to function satisfactorily within established limits
- Military Certification vs. Civil Certification
  - Militarily qualification requires demonstration of airworthiness to protect crew and passengers
  - Civilian certification concentrates on safety of everyone else

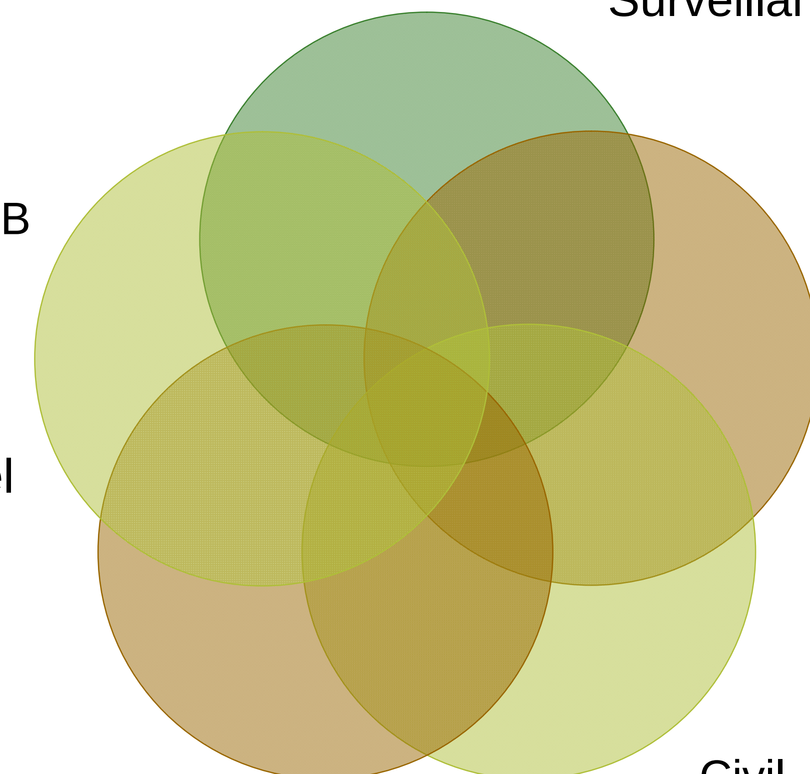
ication?

CH-47 ★ Team Chinook

- Public Concerns for Safety
  - England grounded aircraft for 9 years
  - Spain grounded aircraft until sufficient evidence to release
  - Singapore request data 6 years after delivery
- Foreign Military Concerns

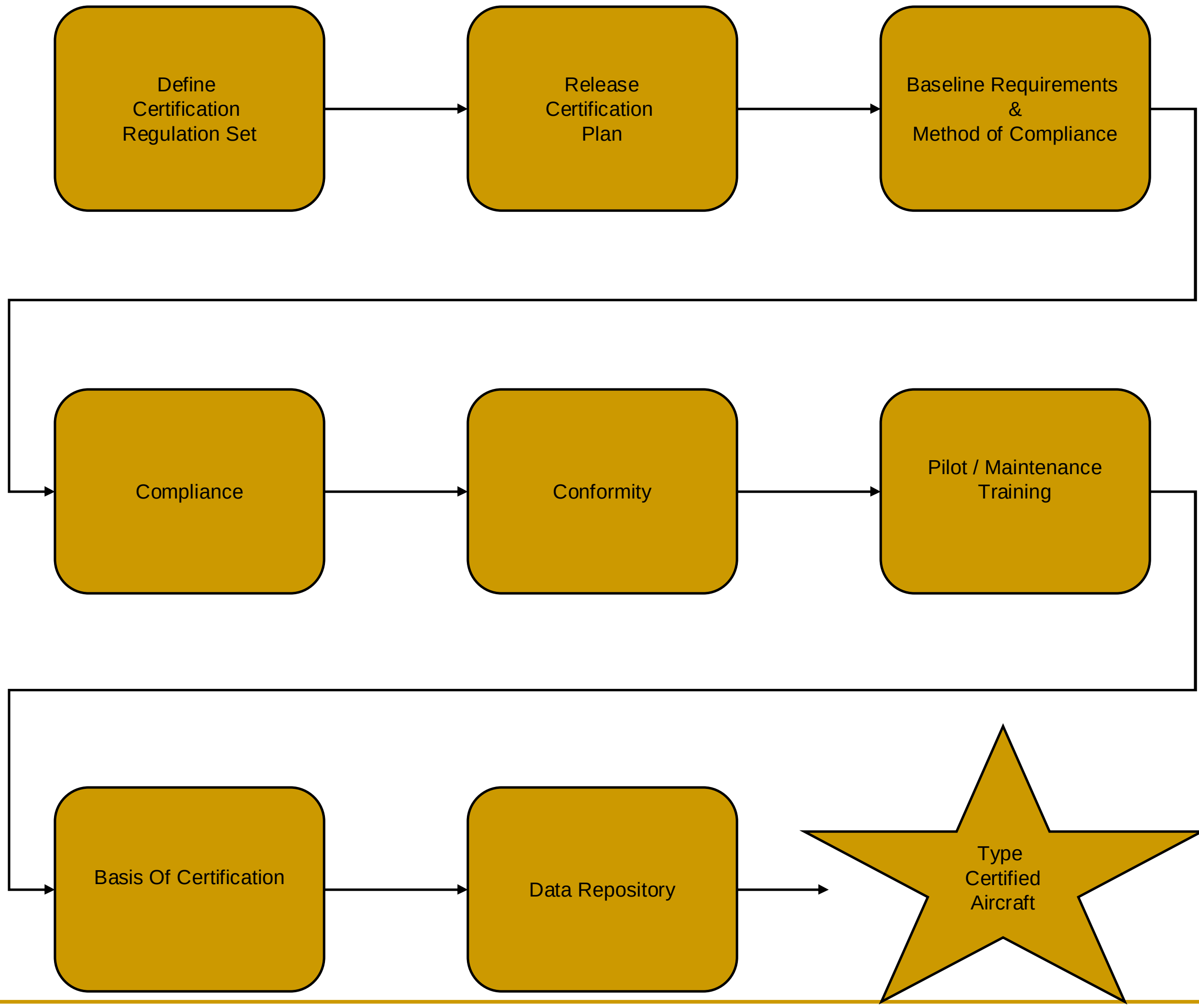
ng Certification

- Methods of Certification varies widely
  - Requirements
  - Process
  - Reciprocity

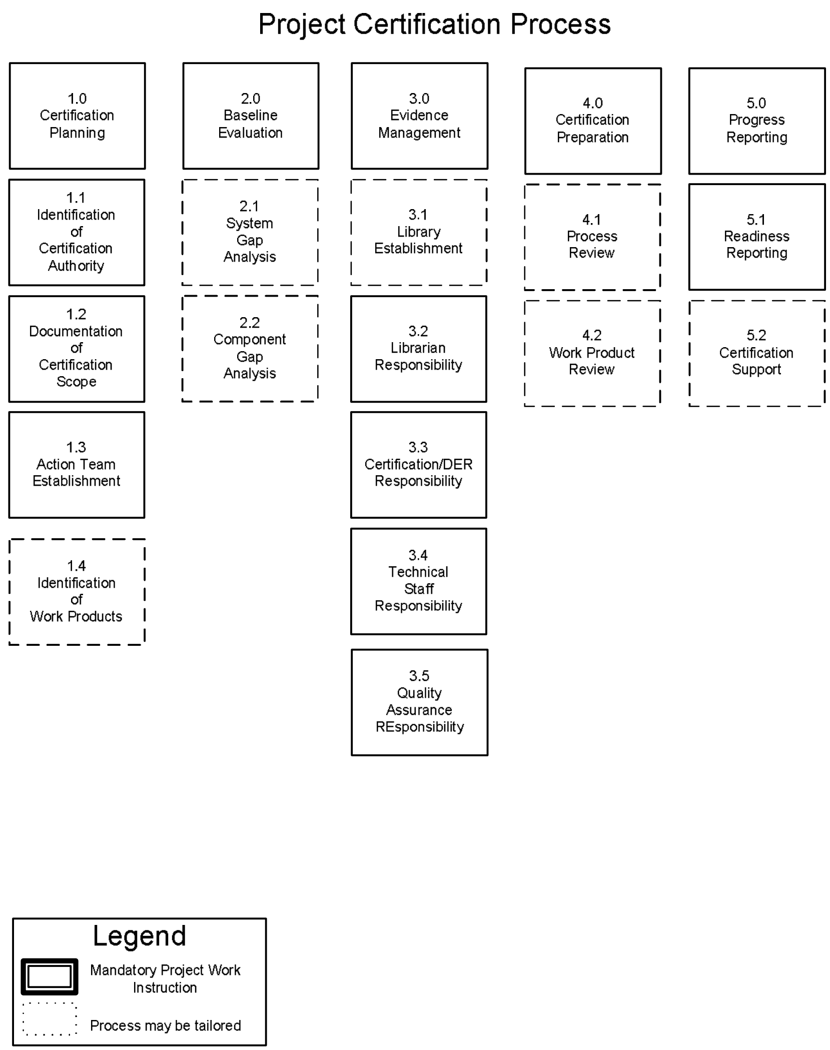


Certification

CH-47 ★ Team Chinook

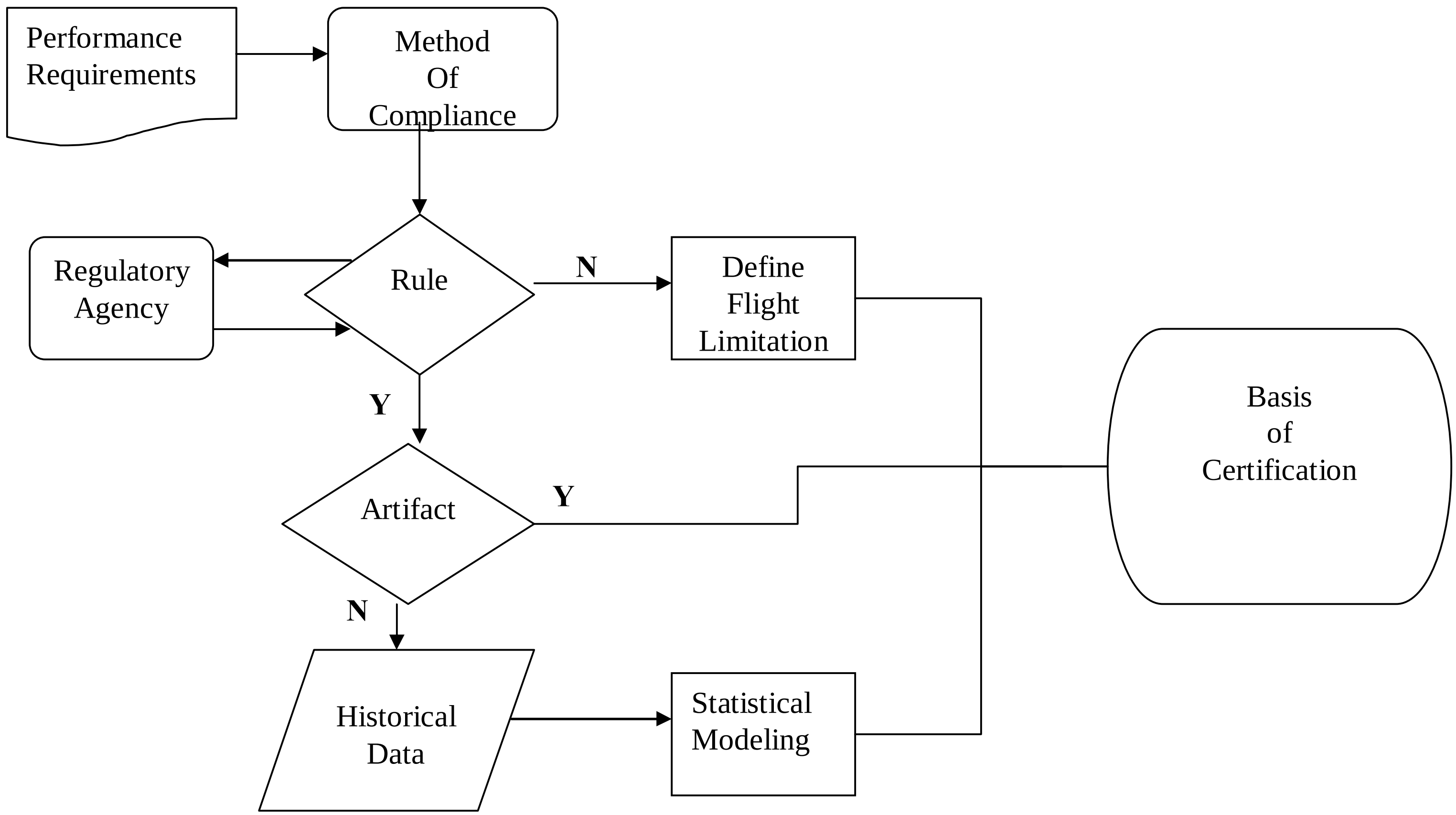


Certificate



craft Certification

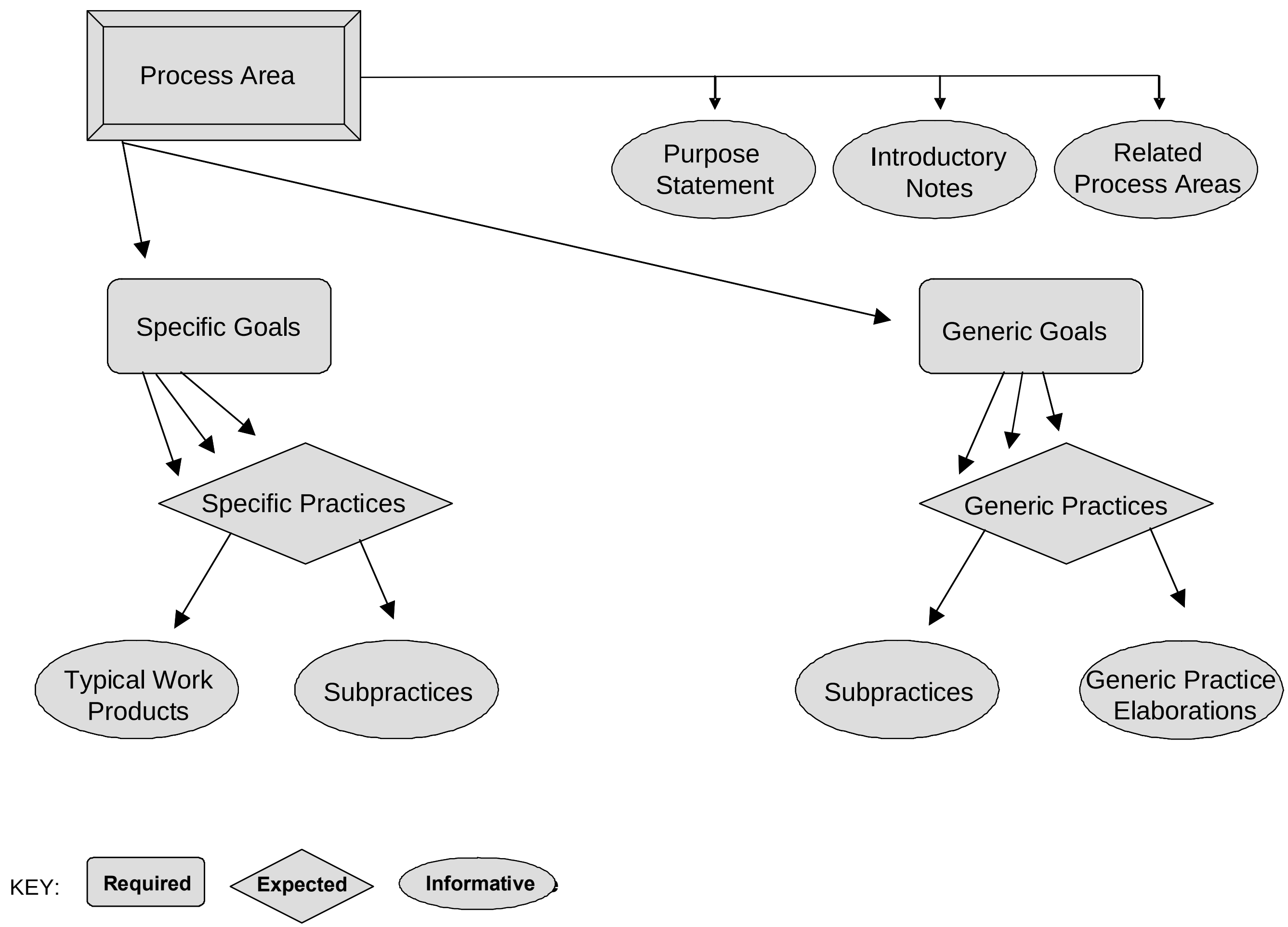
CH-47 ★ Team Chinook



Iterative / Negotiated Process

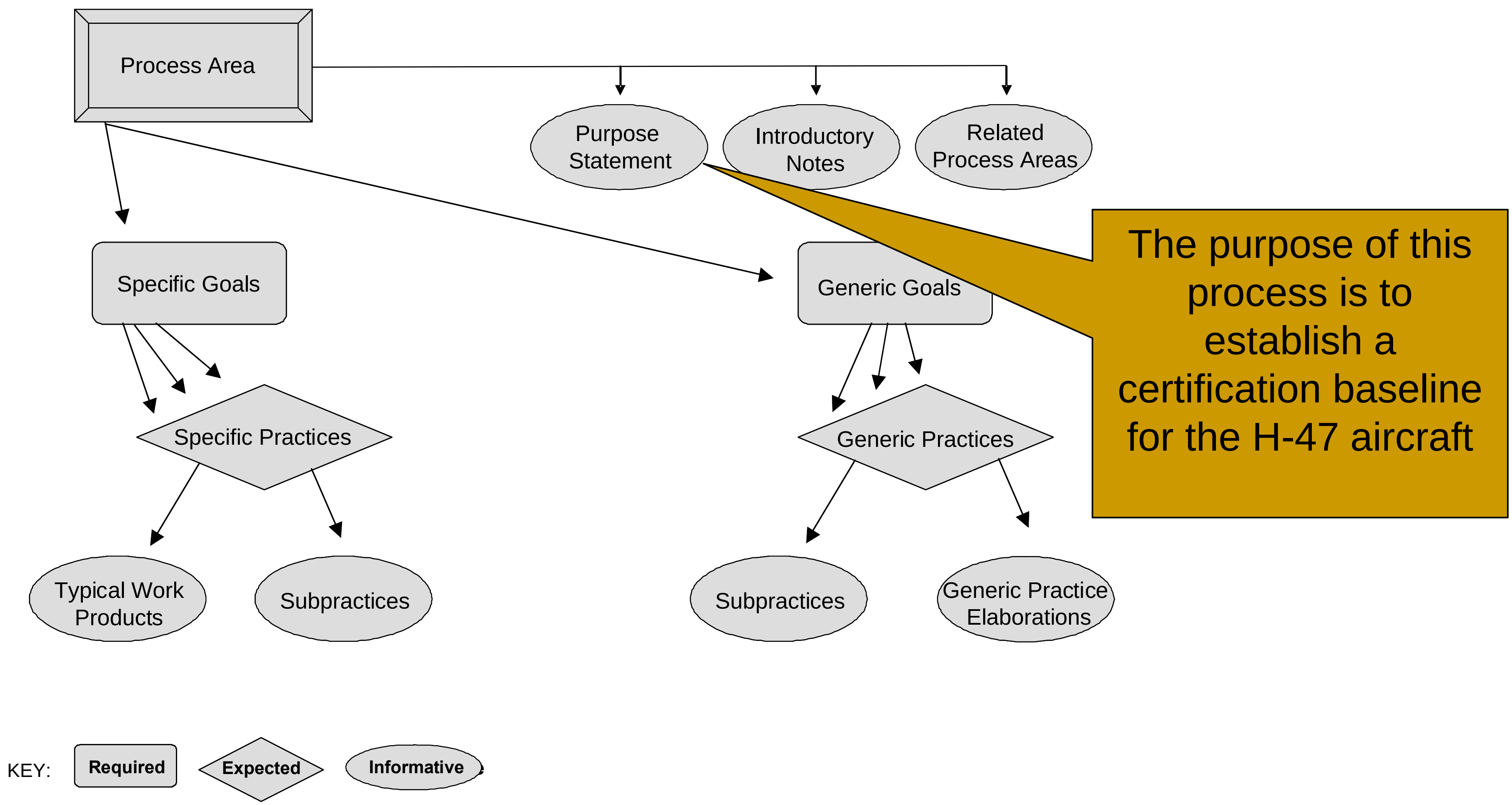
del Fundamentals

CH-47 ★ Team Chinook



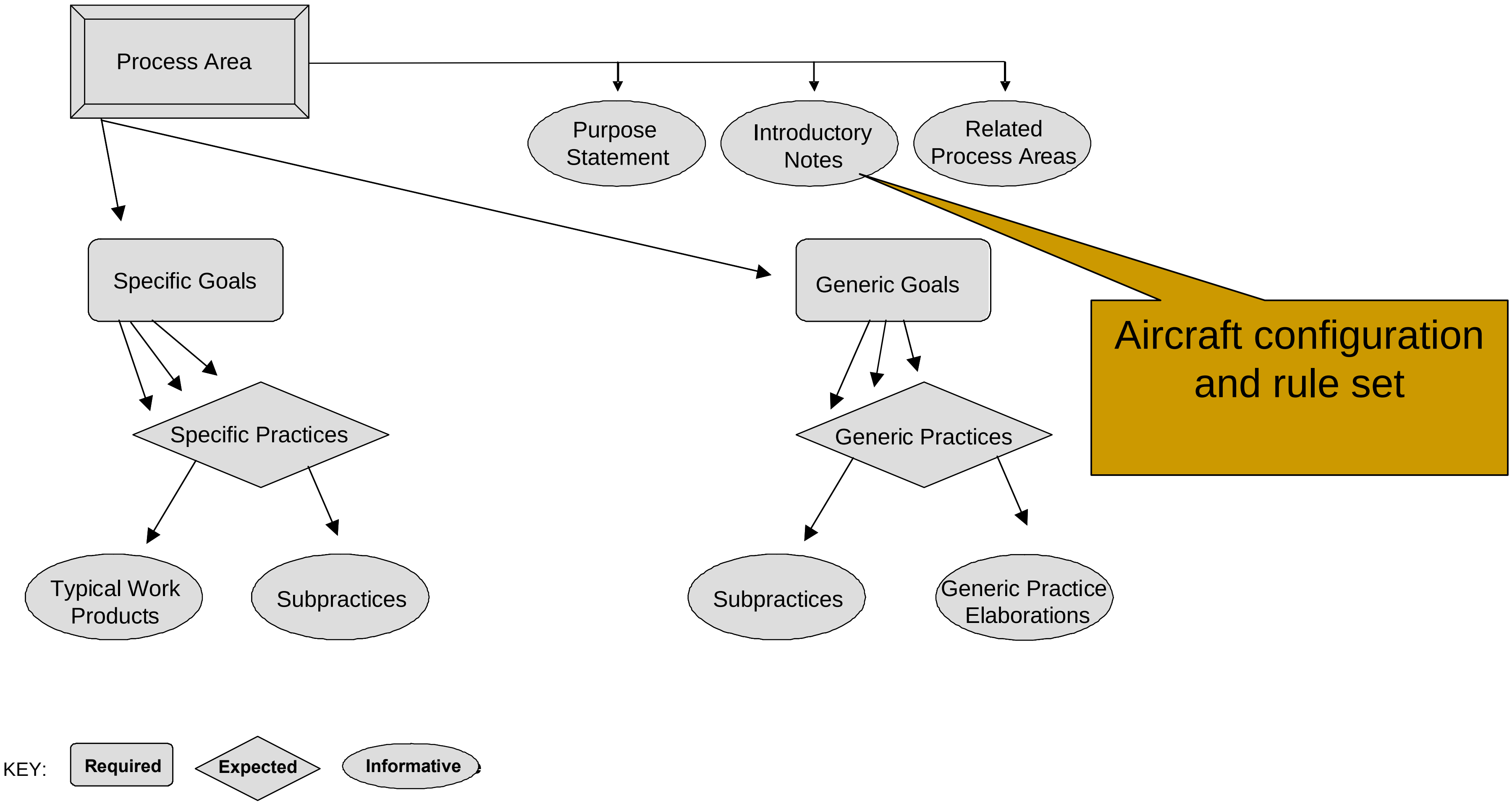
CH-47 ★ Team Chinook

MMI Model to the Certification Process



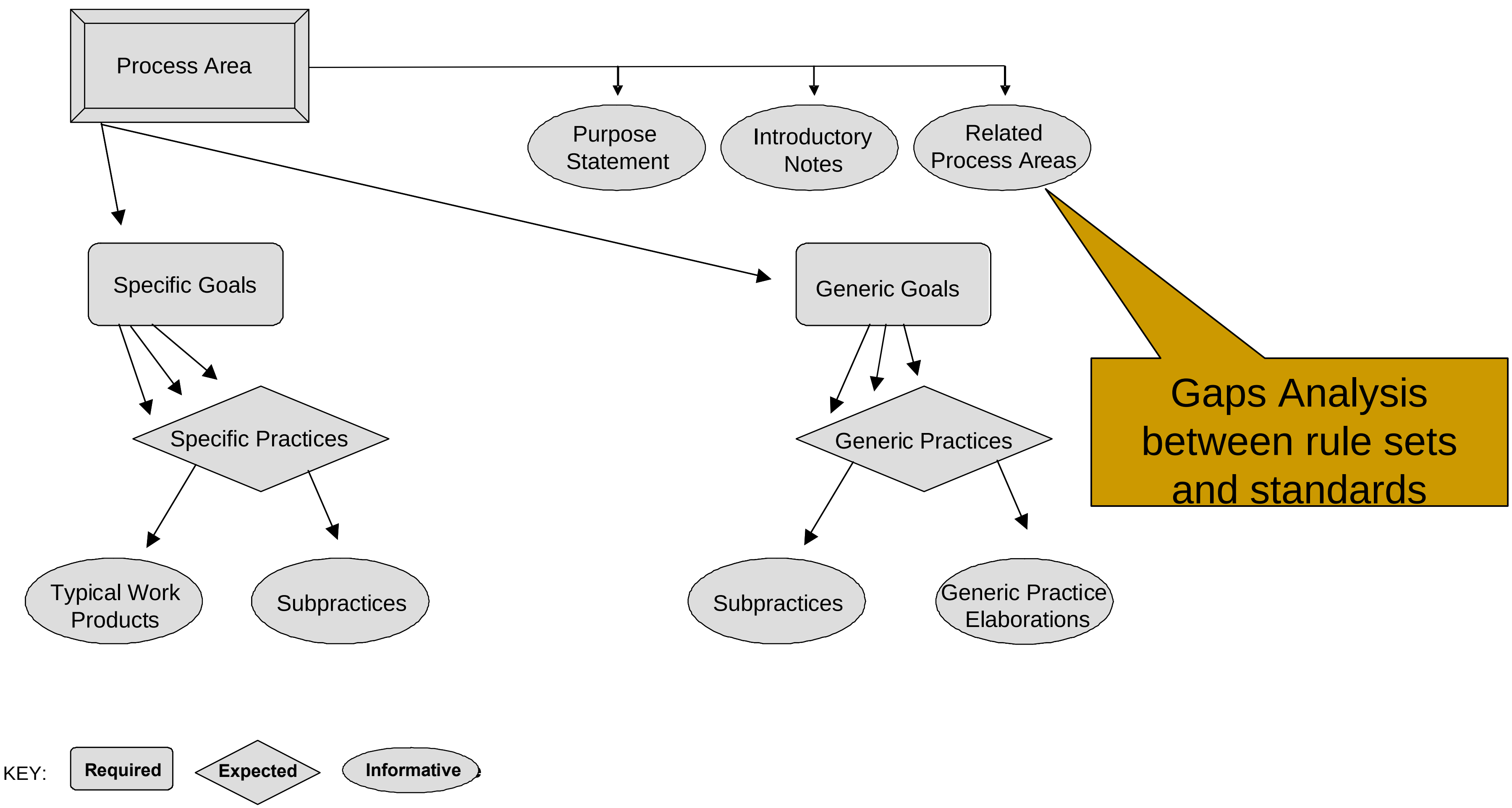
CH-47 ★ Team Chinook

MMI Model to the Certification Process



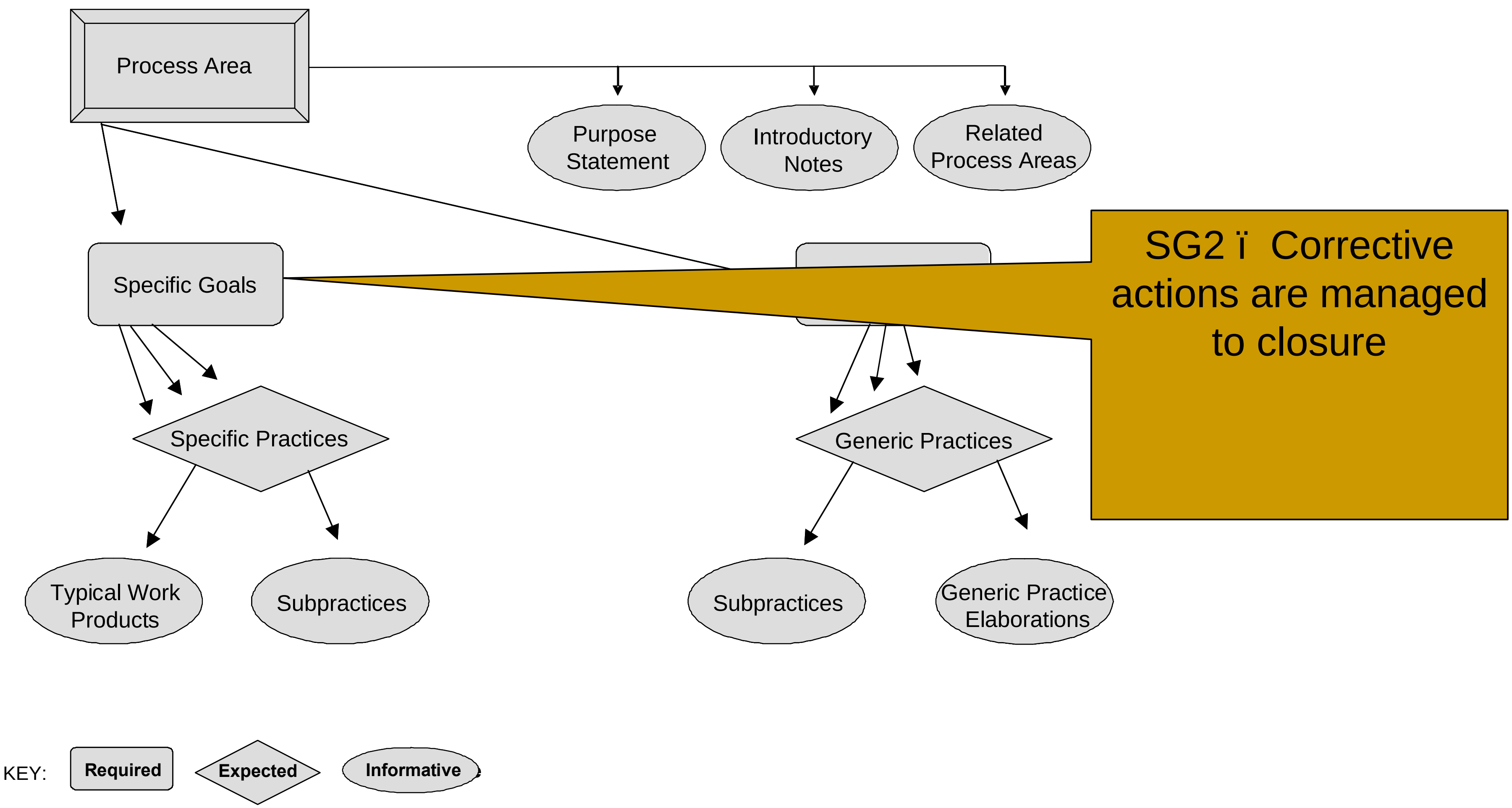
CH-47 ★ Team Chinook

MMI Model to the Certification Process



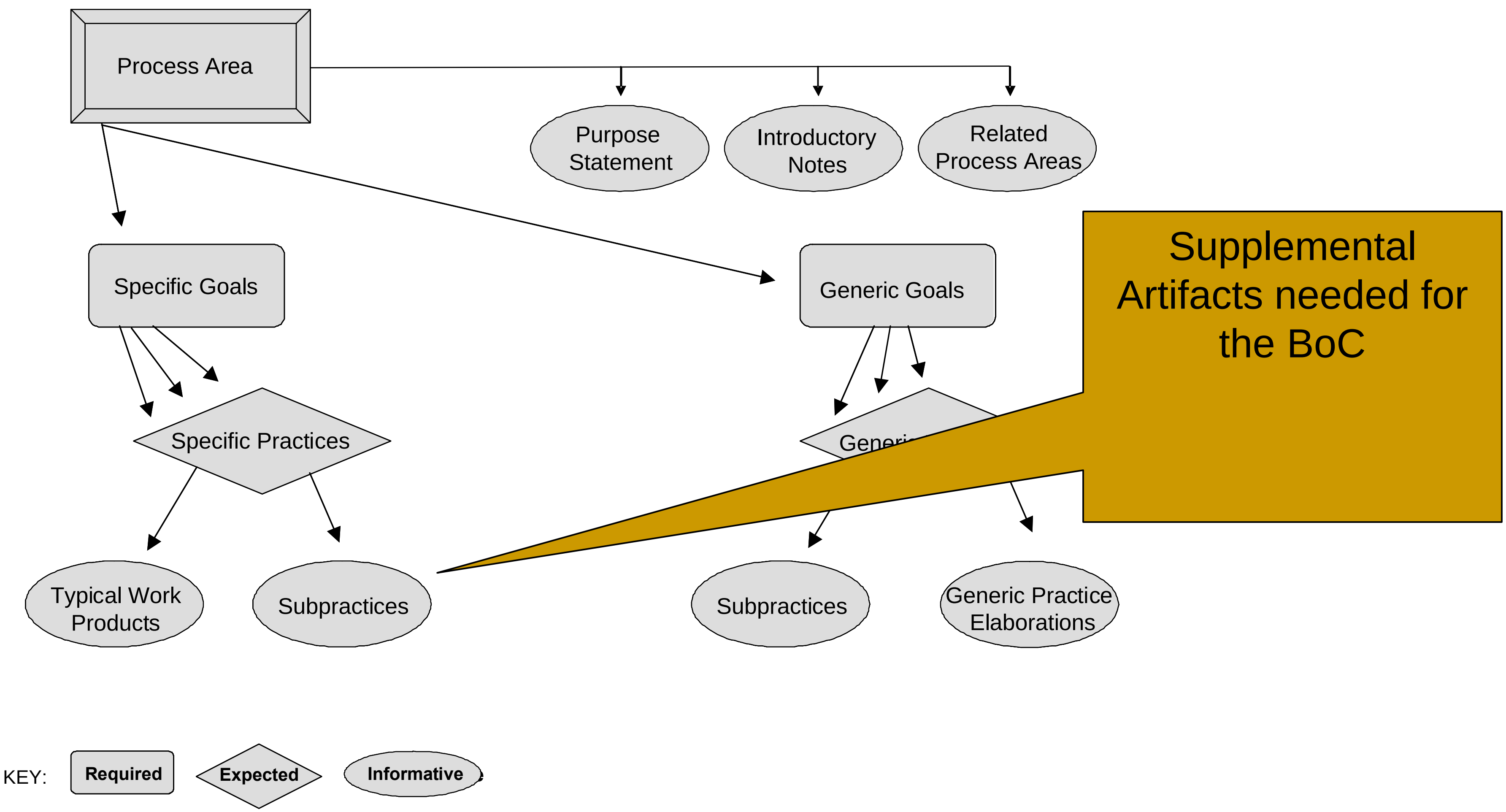
MMI Model to the Certification Process

CH-47 ★ Team Chinook



CH-47 ★ Team Chinook

MMI Model to the Certification Process



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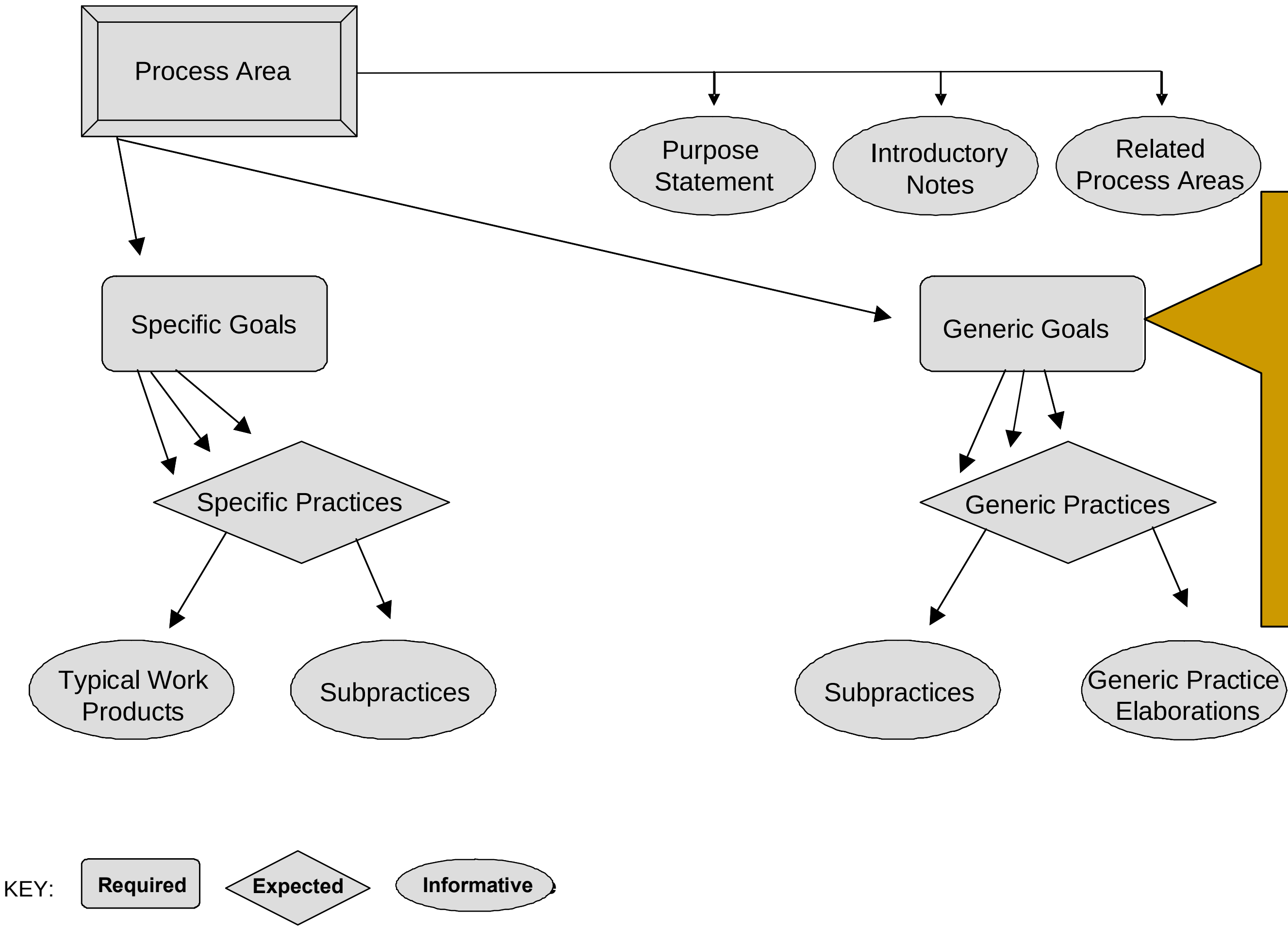
MMI Model to the Certification Process



GG2 ï The process is institutionalized as a managed process

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Accreditation of Undergraduate Programs in Computing, Software Engineering, and Systems Engineering – Ties to CMMI-based Improvement

Seventh CMMI Technology Conference and User Group
Denver, Colorado
November 14, 2007

Dr. Lawrence Jones
Software Engineering Institute

Dan Nash
Raytheon Company

Does This Look Familiar?

Å Set goals.

Å Determine where you are.

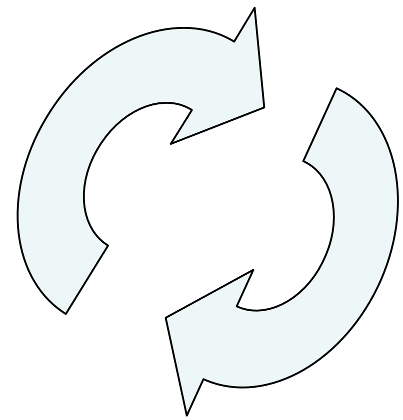
Å Determine where you want to be.

Å Analyze the gap.

Å Make a plan to overcome the gap.

Å Execute the plan.

Å Learn lessons and do it again.



Quality Improvement Cycle

This is being done today in universities.

Your CMMI and improvement expertise is very relevant!

You can help!

Agenda

Å Background

ï Changes in higher education

ï ABET (nee the Accreditation Board for Engineering and Technology)

ï CSAB (nee the Computing Sciences Accreditation Board)

Å The ABET accreditation process

Å Accreditation criteria

Å Status of accreditation of disciplines of interest

Å Government and industry practitioners

ï ABET and CSAB want you!

Forces on Higher Education in Science and Engineering

Å Greater demands for

ï relevance

ï accountability

Å Answers to important questions

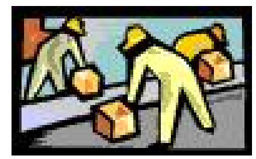
ï How can employers judge preparation of graduates?

ï How can students choose appropriate programs and institutions?

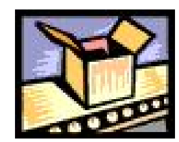
ï How can professions guide the establishment of new programs and improve current programs?

Changes in Educational Approach

- Traditional approach to science and engineering education
  - Emphasis on curricula
    - ***how*** students are educated



  - Culture of independence among faculty
- Target approach for science and engineering education
  - Emphasis on outcomes
    - ***what*** knowledge, skills, abilities graduates possess



  - Emphasis on continuous improvement based on measurement and assessment
  - All this requires greater coordination among faculty
- ABET is a key actor in furthering this approach

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ABET

- established in 1932
  - incorporated computing accreditation responsibility beginning in 2001 (from CSAB, formed in 1982)
- provides a mechanism for professional societies to examine and affect academic quality
- a federation of 31 technical and professional societies representing over 1.8 million technical professionals
- accredits applied science, computing, engineering, and technology programs

Why is ABET Accreditation Important?

Parents and Students . . .

Å Look to accreditation to choose the right study programs.

Employers . . .

Å Rely on accreditation to ensure that employees are qualified to practice.

Licensing and Certification Boards . . .

Å Count on accreditation to screen applicants.

Colleges and Universities . . .

Å Use accreditation as a structured mechanism to assess, evaluate, and improve the quality of their programs.

Graduate Schools . . .

Å Check accreditation to determine the eligibility of applicants.

ABET Governance

ABET Board

Accreditation Council

Engineering Accreditation Commission

1819 accredited programs at 370 institutions

Technology Accreditation Commission

698 accredited programs at 233 institutions

Applied Science Accreditation Commission

70 accredited programs at 53 institutions

Computing Accreditation Commission

286 accredited programs at 236 institutions

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LEADING COMPUTING
CSAB

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- CSAB is a federation of the ACM, IEEE-Computer Society and Association for Information Systems for accreditation issues.
- Formed in 1982 for accrediting computing programs
- Transferred accreditation mechanics responsibilities to ABET beginning in 2001
- Continues on as the “society” representing the member societies on matters of accreditation.
  - computer science
  - information systems
  - information technology
  - software engineering

Agenda

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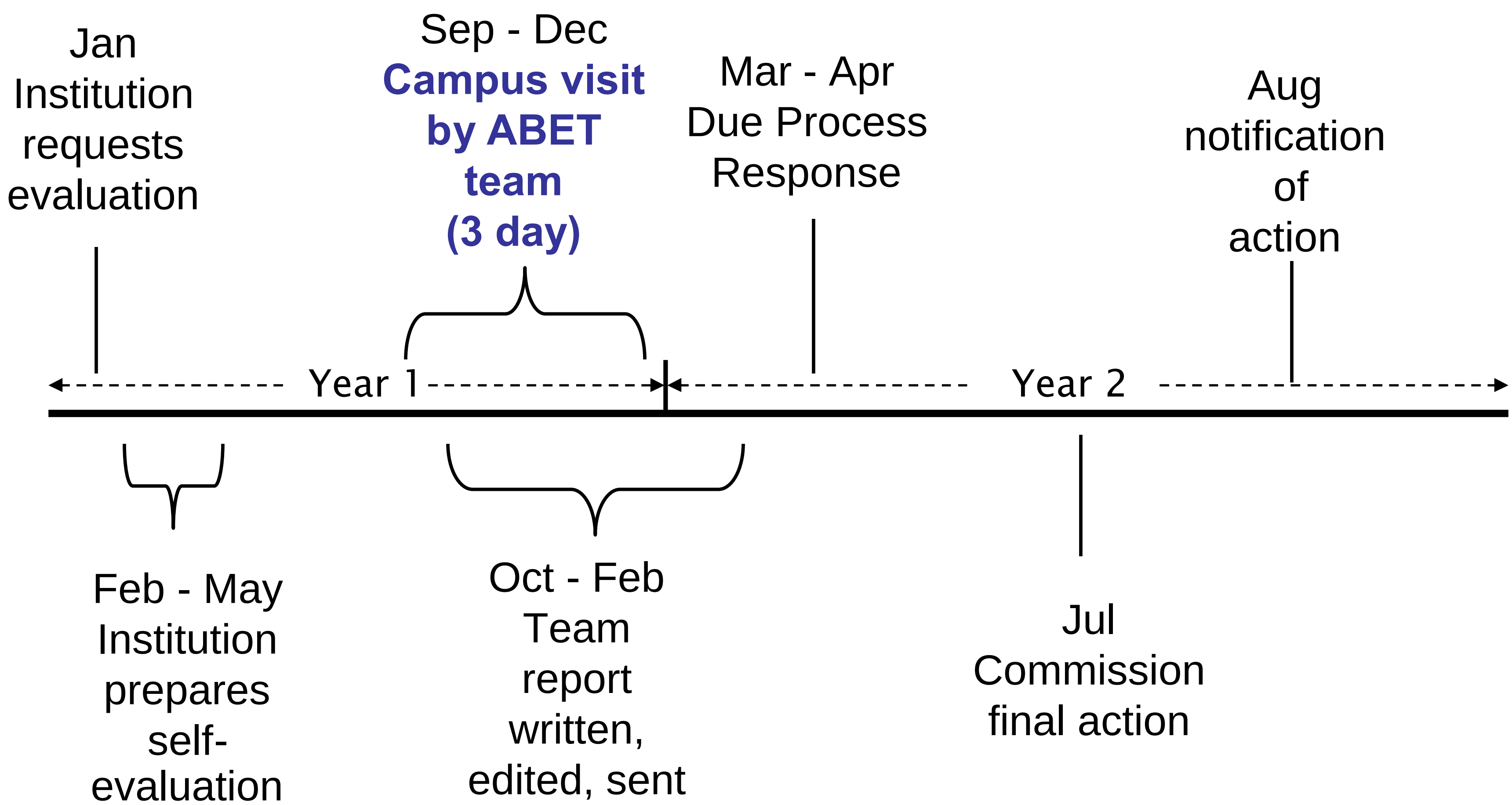
ï ABET and CSAB want you!

Accreditation Timeline



Visit teams

Composition

Å Team Chair

Å Program Evaluators (PEVs) (2 or more)

Team Chair

Å a member of the Commission

Å appointed by the Commission Executive Committee

Å leads the Visit Team

Å interfaces with the institution

Å presents the findings at the July commission meeting

Program Evaluators

Å selected by their member societies (CSAB for computing)

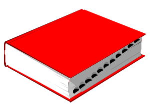
Å provide expert knowledge

Å evaluate programs according to **evaluative criteria**

Program Evaluation

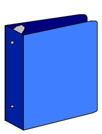
Evaluate program against CAC General and Program criteria and ABET Policies and Procedures.

Pre-visit inputs

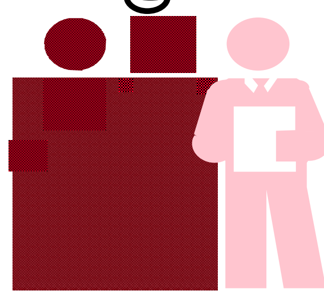


Self Study
Transcripts
Catalogs
Web materials

Visit inputs

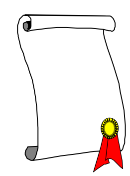


Course displays
Supplements to Self Study
Interviews
Observations

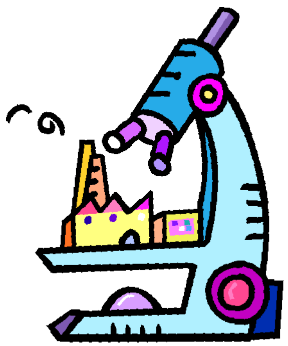


Outputs

Report to institution and ABET (strengths, shortcomings)
Recommended accreditation action to CAC



Are the Ties to Continuous Improvement and CMMI Appraisals Obvious?



Making observations

Comparing observed practices against standards

Applying professional judgment

Agenda

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Å Government and industry practitioners
   ï ABET and CSAB want you!

Criteria Categories

1. Students
2. Program Educational Objectives
3. Program Outcomes
4. Continuous Improvement
5. Curriculum
6. Faculty
7. Facilities
8. Support
9. Program Criteria

Criterion 3: Program Outcomes[1]

- The program has documented, measurable outcomes that are based on the needs of the program's constituencies.
- The program enables students to achieve, by the time of graduation:
  - (a) An ability to apply knowledge of computing and mathematics appropriate to the discipline
  - (b) An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution
  - (c) An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs
  - (d) An ability to function effectively on teams to accomplish a common goal

Criterion 3: Program Outcomes[2]

(e) An understanding of professional, ethical, legal, security and social issues and responsibilities

(f) An ability to communicate effectively with a range of audiences

(g) An ability to analyze the local and global impact of computing on individuals, organizations, and society

(h) Recognition of the need for and an ability to engage in continuing professional development

(i) An ability to use current techniques, skills, and tools necessary for computing practice.

4: Continuous Improvement

- The program uses a documented process incorporating relevant data to regularly assess its program educational objectives and program outcomes, and to evaluate the extent to which they are being met.

- The results of the evaluations are documented and used to effect continuous improvement of the program through a documented plan.

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  - ABET and CSAB want you!

Programs of Specific Interest for This Conference

- Computing Accreditation Commission (currently three program-specific criteria)
  - computer science (250 programs)
  - information systems (30 programs)
  - information technology (7 programs)
- Engineering Accreditation Commission (currently nineteen program-specific criteria)
  - software engineering (15 programs)
  - system engineering currently under consideration

Systems Engineering Accreditation[1]

- INCOSE is pursuing admission as a member of ABET with the intent to be the lead society for *systems engineering*.
- The ABET Board of Directors considered starting the ratification process during its November 3, 2007 meeting.
- Accreditation would fall under the Engineering Accreditation Commission.

Systems Engineering Accreditation²

If INCOSE is admitted, it will need to address Program Evaluator responsibilities.

Through the PAVE (Partnership to Advance Volunteer Excellence) Project common support mechanisms for program evaluators exist for

- a program evaluator competency model
- recruitment and selection
- training and evaluation
- reference: http://www.abet.org/pave.shtml

Agenda

- Background
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Who Are ABET Program Evaluators?

Å **Deans**

Å **Department heads**

Å **Faculty**

Å **Industry leaders**

Å **Government representatives**

Å **Private practitioners**

ABET PROGRAM EVALUATORS: THE FACE OF QUALITY IN TECHNICAL EDUCATION

Additional Industry Program Evaluators Needed

- Practitioner participation is critical
  - Where did the emphasis on continuous improvement and outcomes-orientation come from? ï industry inputs!
- The Computing Accreditation Commission is under-represented in industrial participants
  - 10 industry/government reps out of 47

What Do Program Evaluators Do?

Å Step 1: **Review the self-study report**

Å Step 2: **Visit the campus**

Å Step 3: **Decide whether the program meets the criteria**

Å Step 4: **Travel home and tie up loose ends**

ABET pays travel expenses

Relevant Minimum Qualifications for Program Evaluators

1. **Demonstrated interest in improving education**

2. **Membership in one or more ABET member societies or willingness to become a member prior to applying to serve as an evaluator**

3. **Formal education and recognized distinction in their field**
   a. **Program evaluators with an industry background must possess the following:**
      i. **Degree appropriate to the field**
      ii. **Experience in employment of graduates from accredited programs**

Characteristics of Successful Program Evaluators

Å **Technically current**

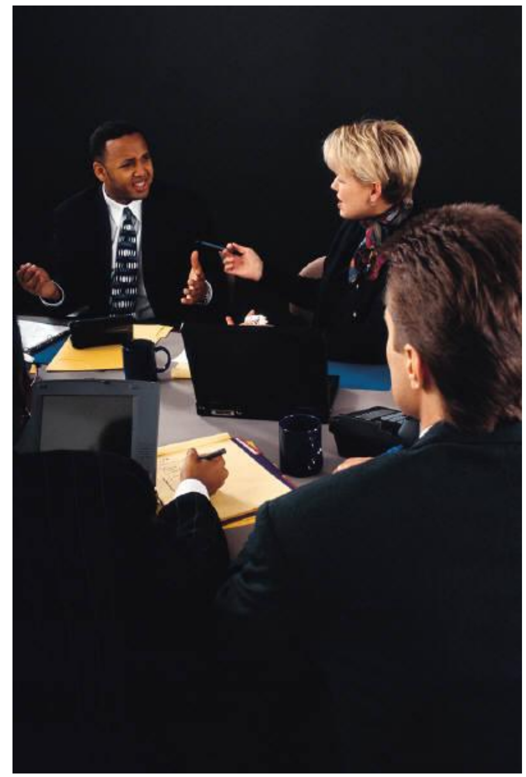
Å **Effective at communicating**

Å **Interpersonally skilled**

Å **Team-oriented**

Å **Professional**

Å **Organized**



Are You Qualified?

- Is there any doubt that CMMI and improvement experience is an excellent background?

How to Apply

1. **Begin the application process to be a CS, IS, IT or SW Engr PEV at http://www.csab.org/pev.htm***

2. **If accepted, you will be asked to complete some online work to prepare for formal program evaluator training.**

3. **If the online work is completed satisfactorily, you will attend formal program evaluator training.**

4. **If the training is completed satisfactorily, you will be approved as a program evaluator. In some cases, you will be asked to observe a campus visit prior to approval as an evaluator.**

5. **Based on your availability and the demand for program evaluators in your field, you will be assigned to evaluate a program.**

*** other disciplines should go to: www.abet.org/volunteer.shtml**

Conclusion

- Additional details are in handouts
- Contact information
  - Larry Jones: lgj@sei.cmu.edu
  - Dan Nash: j_Dan_Nash@raytheon.com
  - Pat LaMalva: lamalva@csab.org
- Apply at
  - **http://www.csab.org/pev.htm**

Backup Slides

Terminology

ABET Term	Definition
Program Educational Objectives	Broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve. (*What can graduates do in about 5 years and continue to do as they grow professionally?)*
Program Outcomes	Narrower statements that describe what students are expected to know and be able to do *by the time of graduation*. These relate to the skills, knowledge, and behaviors that students acquire in their matriculation through the program

Criteria Organization

- Students
- Program Educational Objectives
- Program Outcomes
- Continuous Improvement
- Curriculum
- Faculty
- Facilities
- Support
- Program Criteria

Criterion 1: Students

Students can complete the program in a reasonable amount of time. They have ample opportunity to interact with their instructors. Students are offered timely advising, by qualified individuals, about the program's requirements and their career alternatives. Students who graduate from the program meet all program requirements.

Criterion 2: Program Educational Objectives

The program has ***documented****,* ***measurable*** *educational objectives that are based on the needs of the program's* ***constituencies****.*

Criterion 3: Program Outcomes

The program has documented, measurable outcomes that are based on the needs of the program's constituencies.

The program enables students to achieve, by the time of graduation:

Criterion 3: Program Outcomes

- (a) An ability to apply knowledge of computing and mathematics appropriate to the discipline
- (b) An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution
- (c) An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs
- (d) An ability to function effectively on teams to accomplish a common goal
- (e) An understanding of professional, ethical, legal, security and social issues and responsibilities

Criterion 3: Program Outcomes

Å *(f) An ability to communicate effectively with a range of audiences*

Å *(g) An ability to analyze the local and global impact of computing on individuals, organizations, and society*

Å *(h) Recognition of the need for and an ability to engage in continuing professional development*

Å *(i) An ability to use current techniques, skills, and tools necessary for computing practice.*

Criterion 4: Continuous Improvement

The program uses a documented process incorporating relevant data to regularly assess its program educational objectives and program outcomes, and to evaluate the extent to which they are being met. The results of the evaluations are documented and used to effect continuous improvement of the program through a documented plan.

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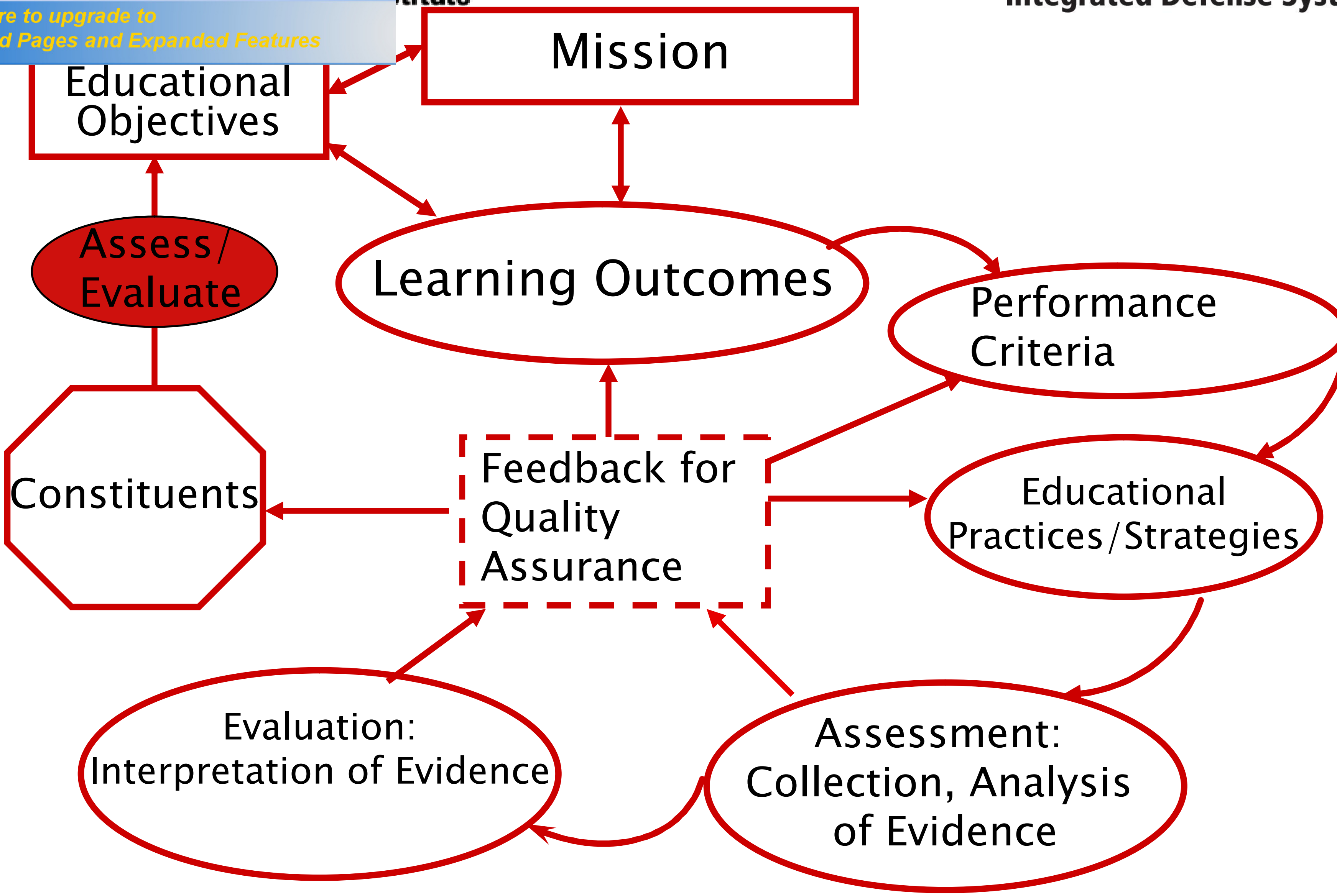

Assessment for Quality Assurance

Criterion 5: Curriculum

The program's requirements are consistent with its educational objectives and are designed in such a way that each of the program outcomes can be achieved. The curriculum combines technical and professional requirements with general education requirements and electives to prepare students for a professional career and further study in the computing discipline associated with the program, and for functioning in modern society. The technical and professional requirements include at least one year of up-to-date coverage of fundamental and advanced topics in the computing discipline associated with the program. In addition, the program includes mathematics appropriate to the discipline beyond the precalculus level. For each course in the major required of all students, its content, expected performance criteria, and place in the overall program of study are published.

Criterion 6: Faculty

- *A. Faculty Qualifications*

  Faculty members teaching in the program are current and active in the associated computing discipline. They each have the educational backgrounds or expertise consistent with their expected contributions to the program. Each has a level of competence that normally would be obtained through graduate work in the discipline, relevant experience, or relevant scholarship. Collectively, they have the technical breadth and depth necessary to support the program.

Criterion 6: Faculty

- *B. Faculty Size and Workload*

  There are enough full-time faculty members to provide continuity, oversight, and stability, to cover the curriculum reasonably, and to allow an appropriate mix of teaching, professional development, scholarly activities, and service for each faculty member. The faculty assigned to the program has appropriate authority for the creation, delivery, evaluation, and modification of the program, and the responsibility for the consistency and quality of its courses.

Criterion 7: Facilities

Institutional facilities including the library, other electronic information retrieval systems, computer networks, classrooms, and offices are adequate to support the educational objectives and outcomes of the program. Computing resources are available, accessible, systematically maintained and upgraded, and otherwise adequately supported to enable students to achieve the program's outcomes and to support faculty teaching needs and scholarly activities. Students and faculty members receive appropriate guidance regarding the computing resources and laboratories available to the program.

Criterion 8: Support

The institution's support for the program and the financial resources available to the program are sufficient to attract and retain qualified faculty members, administer the program effectively, acquire and maintain computing resources and laboratories, and otherwise provide an environment in which the program can achieve its educational objectives and outcomes. Support and resources are sufficient to provide assurance that the program will retain its strength throughout the period of accreditation.

Criterion 9: Program Criteria

Each program must satisfy applicable Program Criteria (if any). Program Criteria provide the specificity needed for interpretation of the General Criteria as applicable to a given discipline. If a program, by virtue of its title, becomes subject to two or more sets of Program Criteria, then that program must satisfy each set of Program Criteria; however, overlapping requirements need to be satisfied only once.

Computer Science

- *3. Program Outcomes*

  The program enables students to achieve, by the time of graduation:

  (j) An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices. [CS]

  (k) An ability to apply design and development principles in the construction of software systems of varying complexity. [CS]

Computer Science

- 5. Curriculum

  Students have the following amounts of course work or equivalent educational experience:

  a. Computer science: One and one-third years that includes:

  1) coverage of the fundamentals of algorithms, data structures, software design, concepts of programming languages and computer organization and architecture. [CS]

  2) an exposure to a variety of programming languages and systems. [CS]

  3) proficiency in at least one higher-level language. [CS]

  4) advanced course work that builds on the fundamental course work to provide depth. [CS]

Computer Science

- *b. One year of science and mathematics:*

  1) Mathematics: At least one half year that must include discrete mathematics. The additional mathematics might consist of courses in areas such as calculus, linear algebra, numerical methods, probability, statistics, number theory, geometry, or symbolic logic. [CS]

  2) Science: A science component that develops an understanding of the scientific method and provides students with an opportunity to experience this mode of inquiry in courses for science or engineering majors that provide some exposure to laboratory work. [CS]

Computer Science

- *6. Faculty*

  A. Qualifications

  Some full time faculty members have a Ph.D. in computer science.

Information Systems

Å *3. Program Outcomes*

The program enables students to achieve, by the time of graduation:

(j) An understanding of processes that support the delivery and management of information systems within a specific application environment. [IS]

Information Systems

Å *5. Curriculum*

Students have course work or an equivalent educational experience that includes:

a. Information Systems: One year that includes:

1) coverage of the fundamentals of a modern programming language, data management, networking and data communications, systems analysis and design and the role of Information Systems in organizations. [IS]

2) advanced coursework that builds on the fundamental coursework to provide depth. [IS]

b. Information Systems Environment: One-half year of coursework that includes varied topics that provide background in an environment in which the information systems will be applied professionally. [IS]

c. Quantitative analysis or methods including statistics. [IS]

Information Systems

- *6. Faculty*

  Some full-time faculty, including those responsible for the IS curriculum development, hold a terminal degree in information systems.

Information Technology

- 3. Program Outcomes

  The program enables students to achieve, by the time of graduation:

  (j) An ability to use and apply current technical concepts and practices in the core information technologies. [IT]

  (k) An ability to identify and analyze user needs and take them into account in the selection, creation, evaluation and administration of computer-based systems. [IT]

  (l) An ability to effectively integrate IT-based solutions into the user environment. [IT]

  (m) An understanding of best practices and standards and their application. [IT]

  (n) An ability to assist in the creation of an effective project plan. [IT]

Information Technology

- *5. Curriculum*

  Students have course work or an equivalent educational experience that includes:

  a. Coverage of the fundamentals of

  1) the core information technologies of human computer interaction, information management, programming, networking, web systems and technologies. [IT]

  2) information assurance and security. [IT]

  3) system administration and maintenance. [IT]

  4) system integration and architecture. [IT]

  b. Advanced course work that builds on the fundamental course work to provide depth. [IT]

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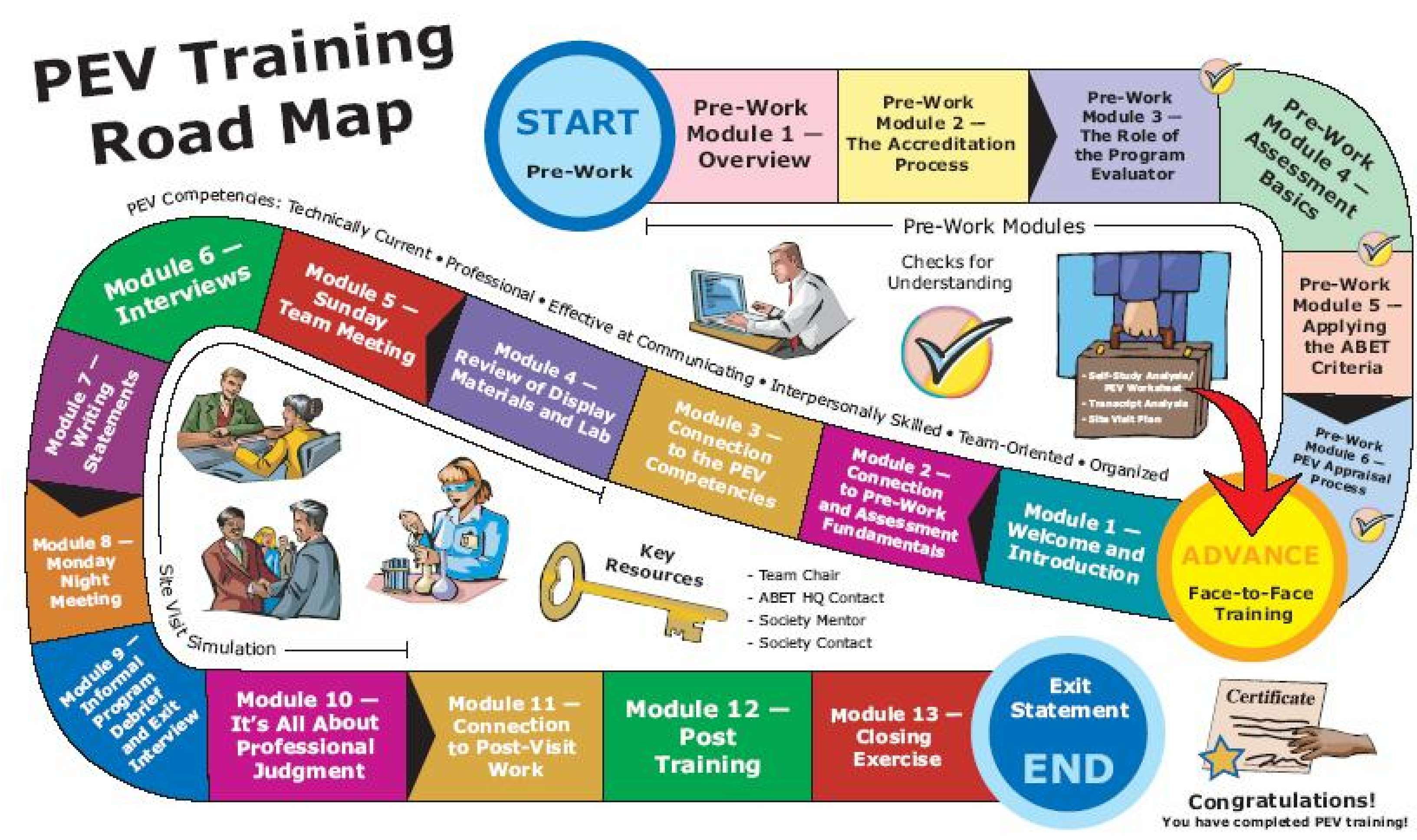
Program Evaluator Training



Note: Travel expenses for training paid by ABET

Systems Engineering - How Future Trends in Systems and Software Technology Bode Well for the Rapid Adoption of CMMI

CMMI Technology Conference and User Group
November 12-15, 2007
Investigation, Measures and Lessons Learned about the Relationship between CMMI Process Capability and Project or Program Performance
Hyatt Regency Tech Center- Denver, CO
Systems and Software Technology – Enabling the Global Mission

Dr. Kenneth E. Nidiffer
Director of Strategic Plans for Government Programs
nidiffer@sei.cmu.edu
703.908.1117

…neering Institute - Improving the Practice …eering: Create, Apply and Amplify

Federally Funded Research and Development Center

Created in 1984

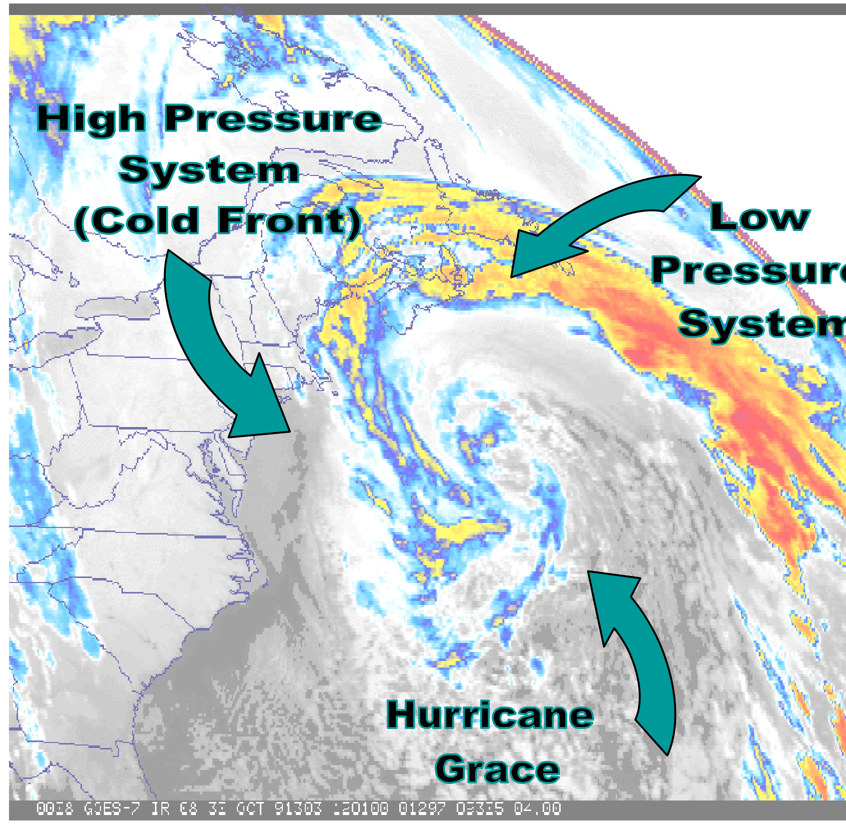
Sponsored by the U.S. Department of Defense

Locations in Pittsburgh, PA; Washington, DC; Frankfurt, Germany

Operated by Carnegie Mellon University

Overview

- Environmental Challenges
  - Development
  - Acquisition
- Storms of Change
  - Human Element
  - Project/Risk Management
  - Communications
- Warning Signs
- Concluding Comments



"Perfect Storm" Event, October 1991
National Oceanic & Atmospheric Administration

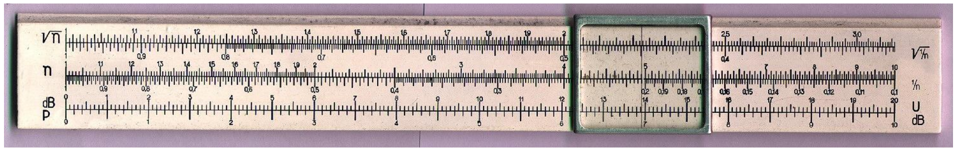
...enges: Software Engineering Trends That ...gineering*

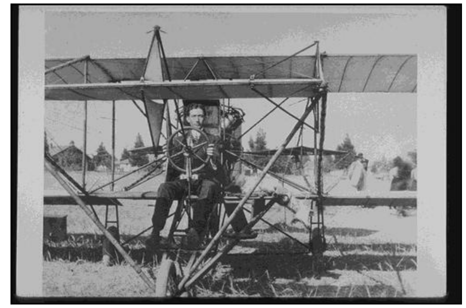
Traditional	Future
Standalone systems	Everything connected-maybe
Mostly source code	Mostly COTS components
Requirements-driven	Requirements are emergent
Focus on software	Focus on systems and software
Premium on cost	Premium on value, speed, quality
Stable requirements	Rapid Change
Control over evolution	No control over COTS evolution
Staffing workable	Scarcity of critical talent

ÅTrends provided by Don Reifer, REIFER CONSULTANTS, INC.

…enges: Augustine's Law – Growth of Software – Order of Magnitude Every 10 Years

In The Beginning





1960's

F-4A 1000 LOC

1970's

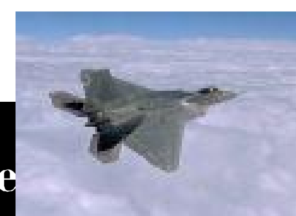
F-15A 50,000 LOC

1980's

F-16C 300K LOC

1990's

F-22 1.7M LOC



2000+

F-35 >6M LOC

...llenges: Relationship Between Complexity ...uccess Improving But Not Enough!

Software is Growing in Complexity

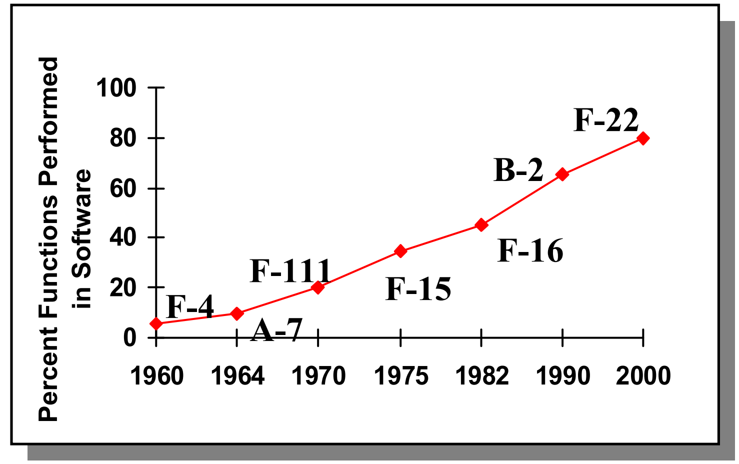
- 80% of some weapon system functionality is dependent upon software[1]
- Consequences of software failure can be catastrophic

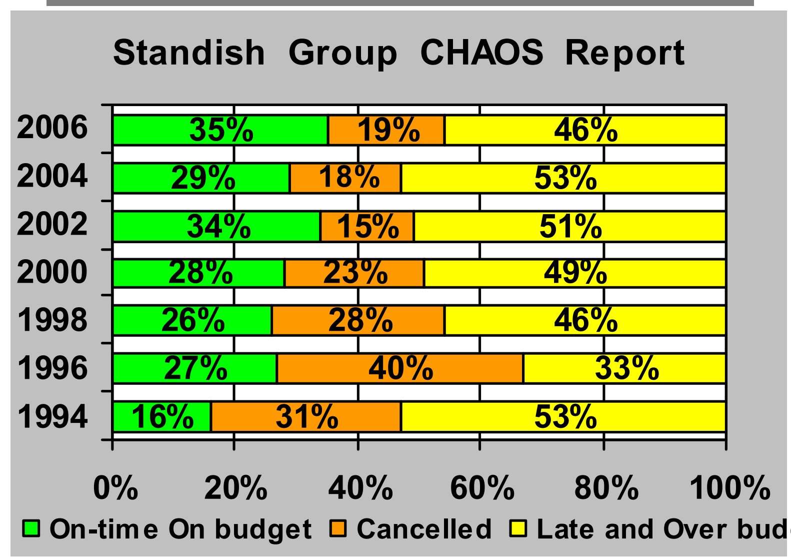
Software Acquisition is Difficult

- 46% are over-budget (by an average of 47%) or late (by an average of 72%)[2]
- "Successful projects" have 68% of specified features[2]

Software is Pervasive

- IT Systems, C4ISR, Weapons, etc





…ges: Some Drivers That Increase the …ring Software-Intensive Systems

Platform → **Enterprise**
Customer Emphasis

Requirements → **Objectives**
Acquisition Model

Dominant Prime → **Strategic Teaming**
Program Execution

"Boxes" → **"Layers & Stacks"**
Integration Challenge

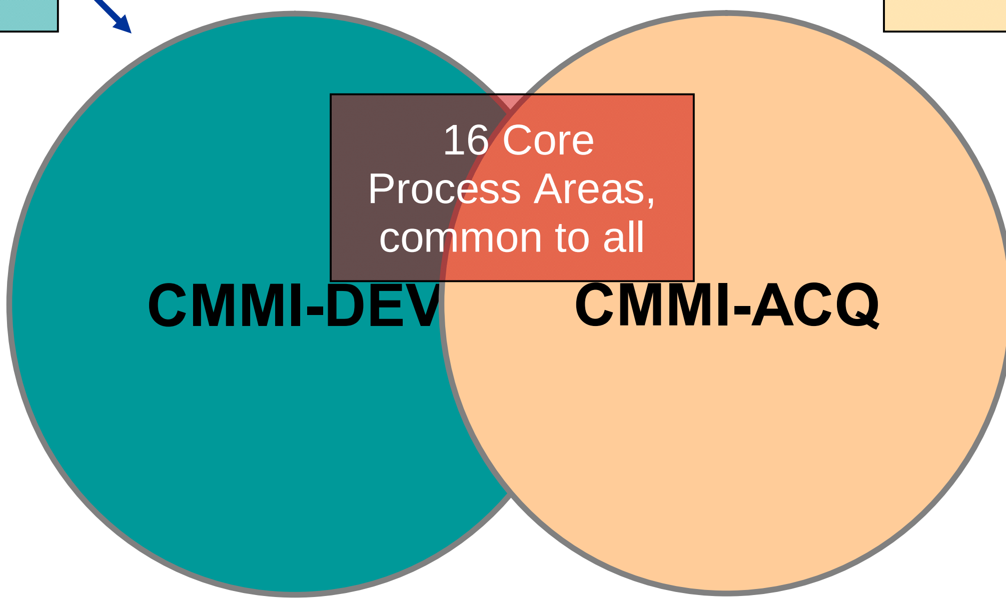
Proprietary → **Plug & Play**
Architectures and Standards

The emerging dynamic is to address both sides, and do so with compressed delivery schedules via improvements in systems/software engineering

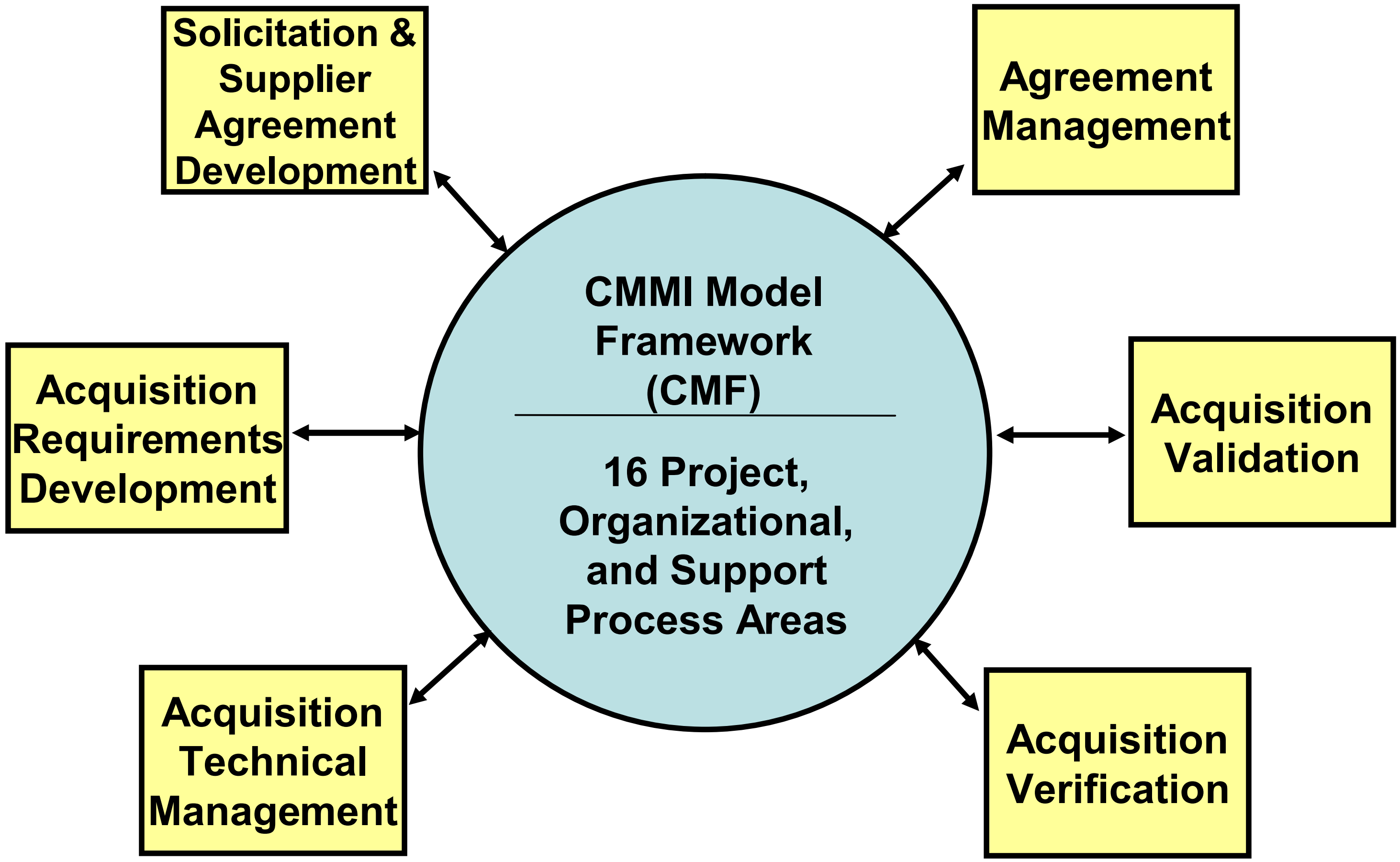
d Acquisition Challenges: CMMI Constellations

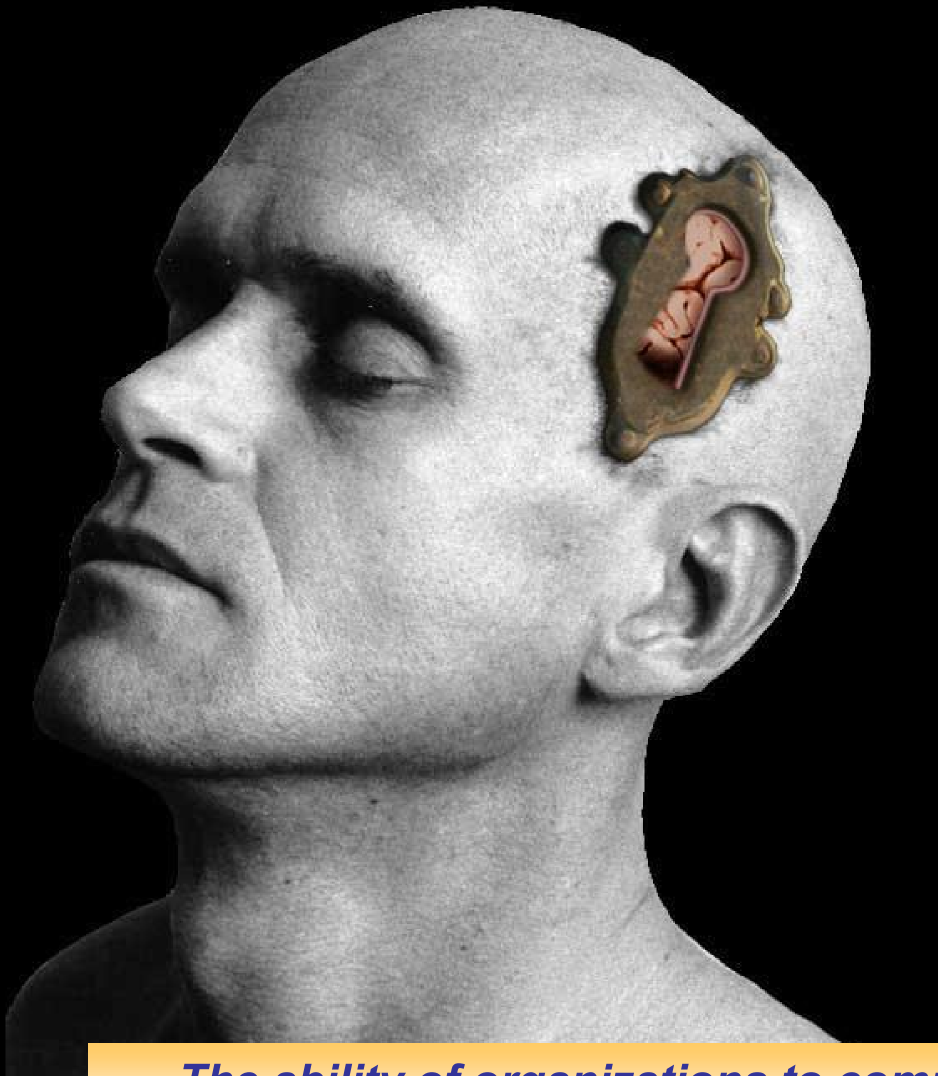
CMMI-Dev provides guidance for measuring, monitoring and managing development processes

CMMI-ACQ provides guidance to enable informed and decisive acquisition leadership



Acquisition Category Process Areas (Released Nov)





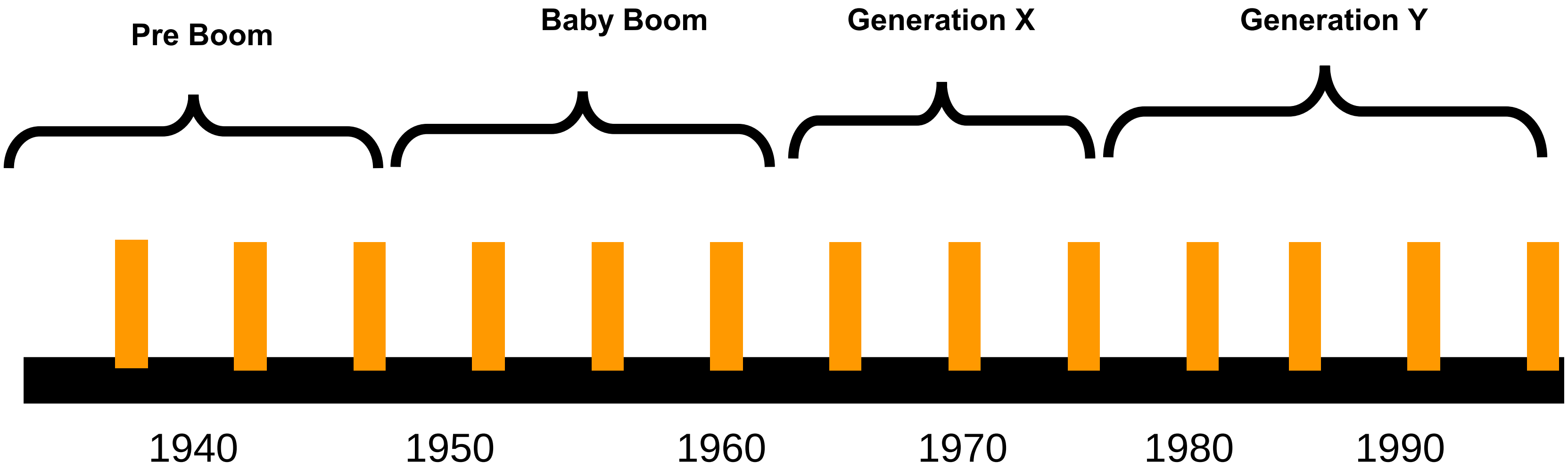
The ability of organizations to compete will increasing depend on the innovation of the human element

he Demographic Context…

- A shrinking pool of experienced workers.
  - **42% decline from 1990 peak *(AIA Employment Database)***
- Consolidation left our industry with a mature workforce.
  - **54% over age 45 *(BAH Study)***
- Engineering enrollment trends are down.
  - **15% decline since 1991 *(National Science Foundation Indicators)***
- Brutal competition for technologists.
  - **Demand for experienced engineers is projected to increase by 97% between 1998 and 2008. *(US Bureau of Labor Statistics)***

A key challenge is how to transform the workforce to meet demand

…re Generation Y Workers Will Enter the Workplace



Generation Y Characteristics

ÅBorn late 1970s to mid-1990s

ÅLarger than Generation X

ÅMore ethnically diverse

ÅTechnologically savvy

What Makes Generation Y Tick

ÅHigh Expectation of Employers

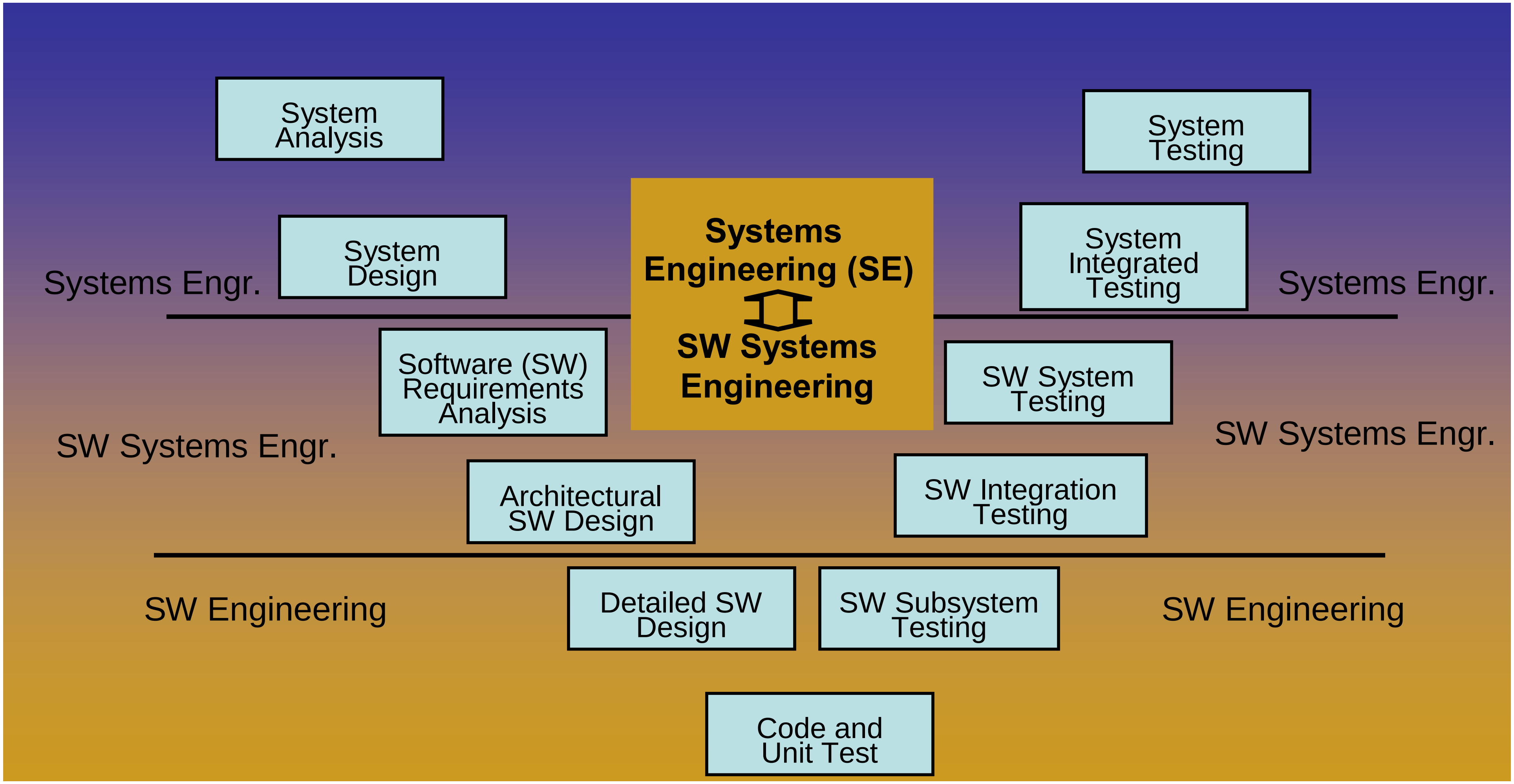
ÅGoals, Goals, Goals

ÅDesire for Immediate Responsibility

ÅBalance and Flexibility

Source: Cara Spiro, DAU, 2006

urrent Trends is for Software and Systems ome More Integrated Versus Separated



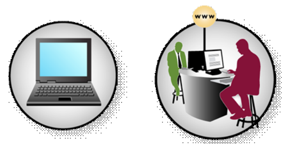
OSD Initiative: Integrated Software and Systems Engineering Curriculum

Software and Systems Engineering Curriculum Project (*iSSEc*)

- **Creating a Reference Curriculum for Graduate Software Engineering Education**
- ***iSSEc* is sponsored by DOD and led by Stevens, involving 4 sets of stakeholders:**
  - The industrial and government workforce who are the customers of SWE graduate education
  - Academics who provide SWE and SE graduate education
  - Professional societies with a vested interest in SWE and SE graduate education
  - Government organizations who fund improvements in SWE graduate education
- ***iSSEc* recognizes that the divide between systems and software engineers in industry, government, and academia works against successfully delivering modern systems in which software is almost always central.**
- ***iSSEc* will integrate SE principles and practices into the SWE curriculum.**

STEVENS Institute of Technology

Performance - Flexible Boundary-Crossing Acquisition Structure



Demands/ Purposes

Autonomous Governance Entities

	Anticipated	Unanticipated
Multiple	Directed Collaboration (Type II Agility)	Distributed Collaboration (Type III Agility)
Single	Directed (Type I Agility)	Directed (Type I Agility + Contingency Planning)

Forms of Collaboration from "Architecting Principles for Systems of Systems", by Mark W. Maier
http://www.infoed.com/open/papers/systems.htm

...rformance - Flexible Boundary-Crossing ...ture

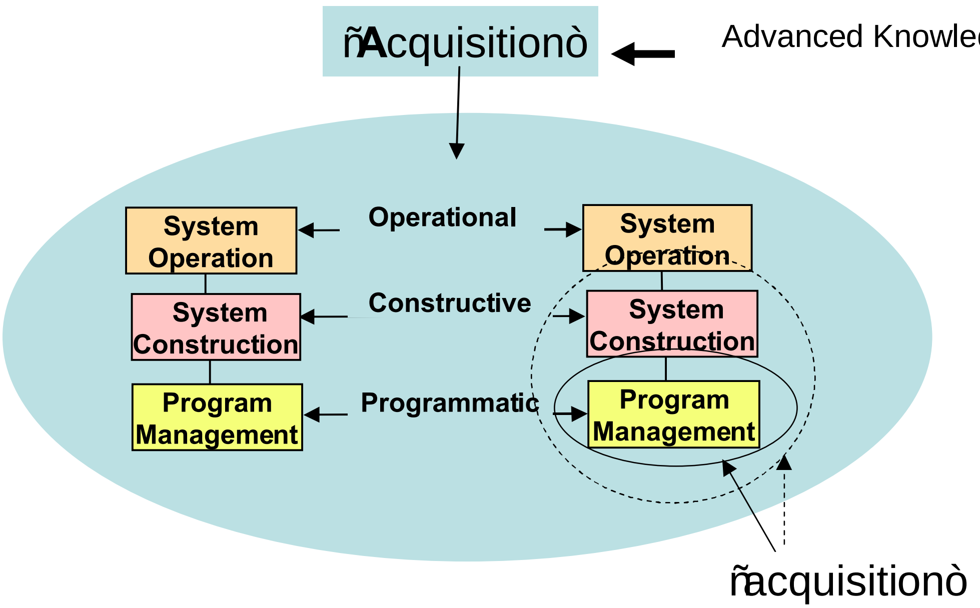
2005 study confirmed*:

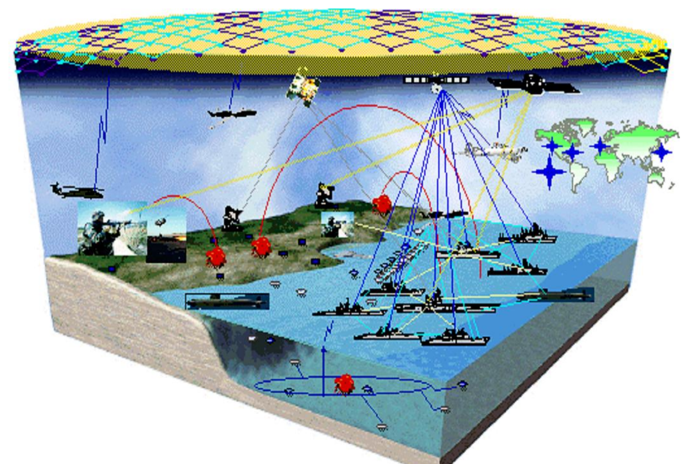
ÅIn advanced knowledge-based organizations, managementõs desire for the flow of knowledge is greater than the desire to control boundaries

ÅUnlike the matrix organization, there is less impact on the dynamics of formal power and control

ÅImportant to measure the system in terms of user performance

* Using Communities of Practice to Drive Organizational Performance and Innovation, 2005, APQ study





From ñScience and Technology to Support FORCEnet,ò Raytheon TD-06-008. Used by permission.

Ref: Jim Smith, (703) 908-8221, jds@sei.cmu.edu

…t: Increased Focus on Doing More with Less

Random motion ï lots of energy, not much progress

No teamwork ï individual effort

Frequent conflict

You never know where youõll end up

Directed motion ï every step brings you closer to the goal

Coordinated efforts

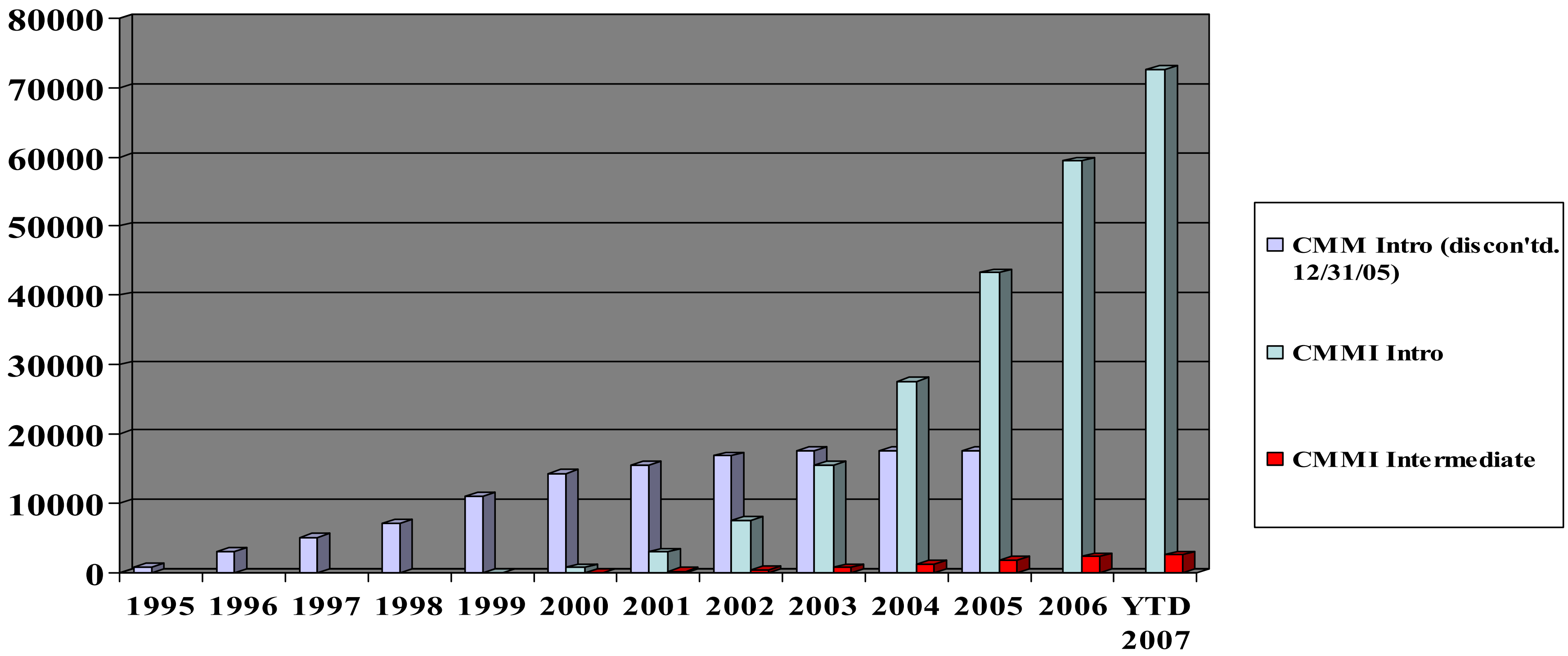
Cooperation

Predictable results

Processes Can Make the Difference

MM and CMMI Technology Transfer Trends

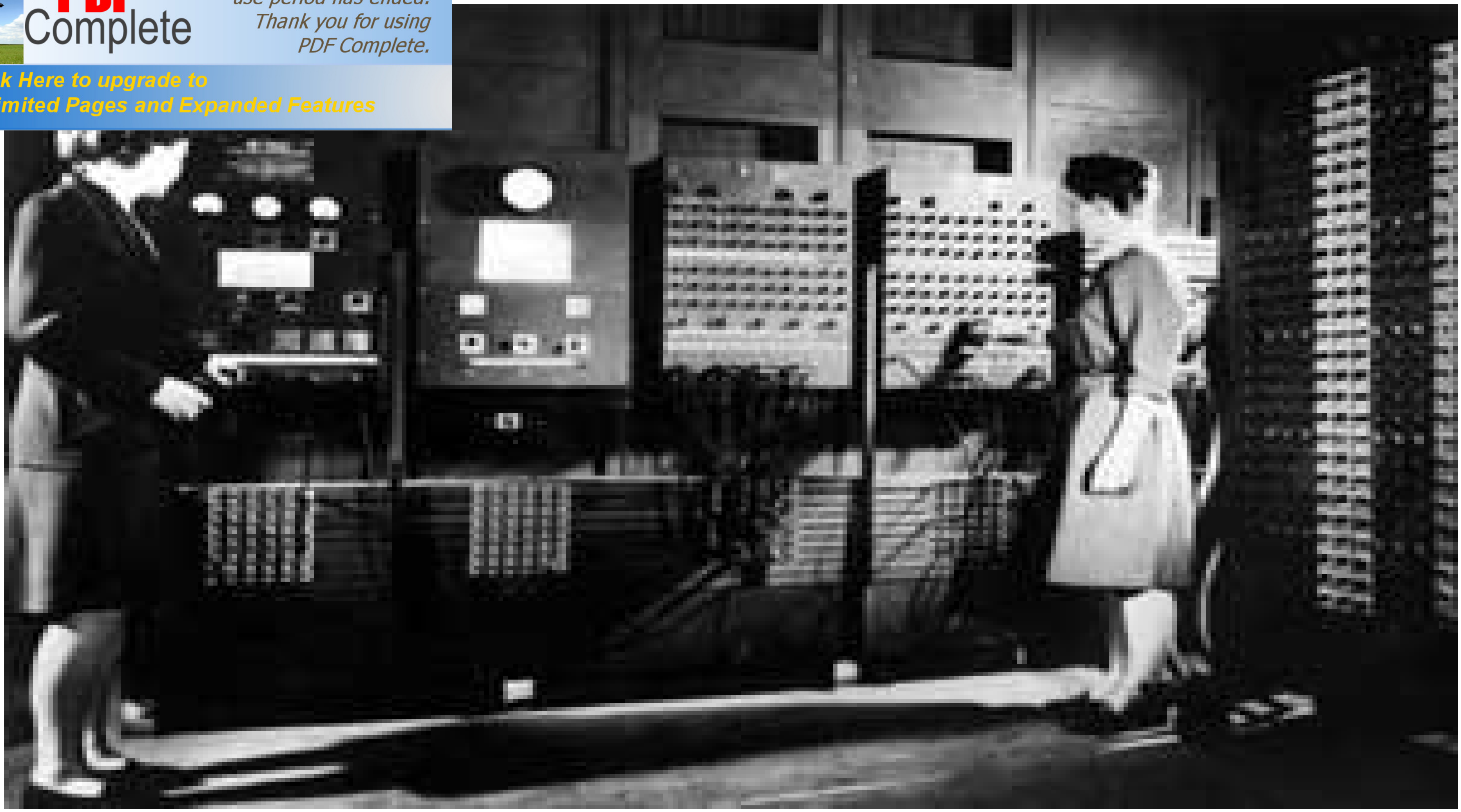
Intro to the CMM and CMMI Attendees (Cumulative)



8-31-07

ment – Effectively Managing Risk

A key challenge is how to obtain a better alignment of risk among the key stakeholders who often leverage technology



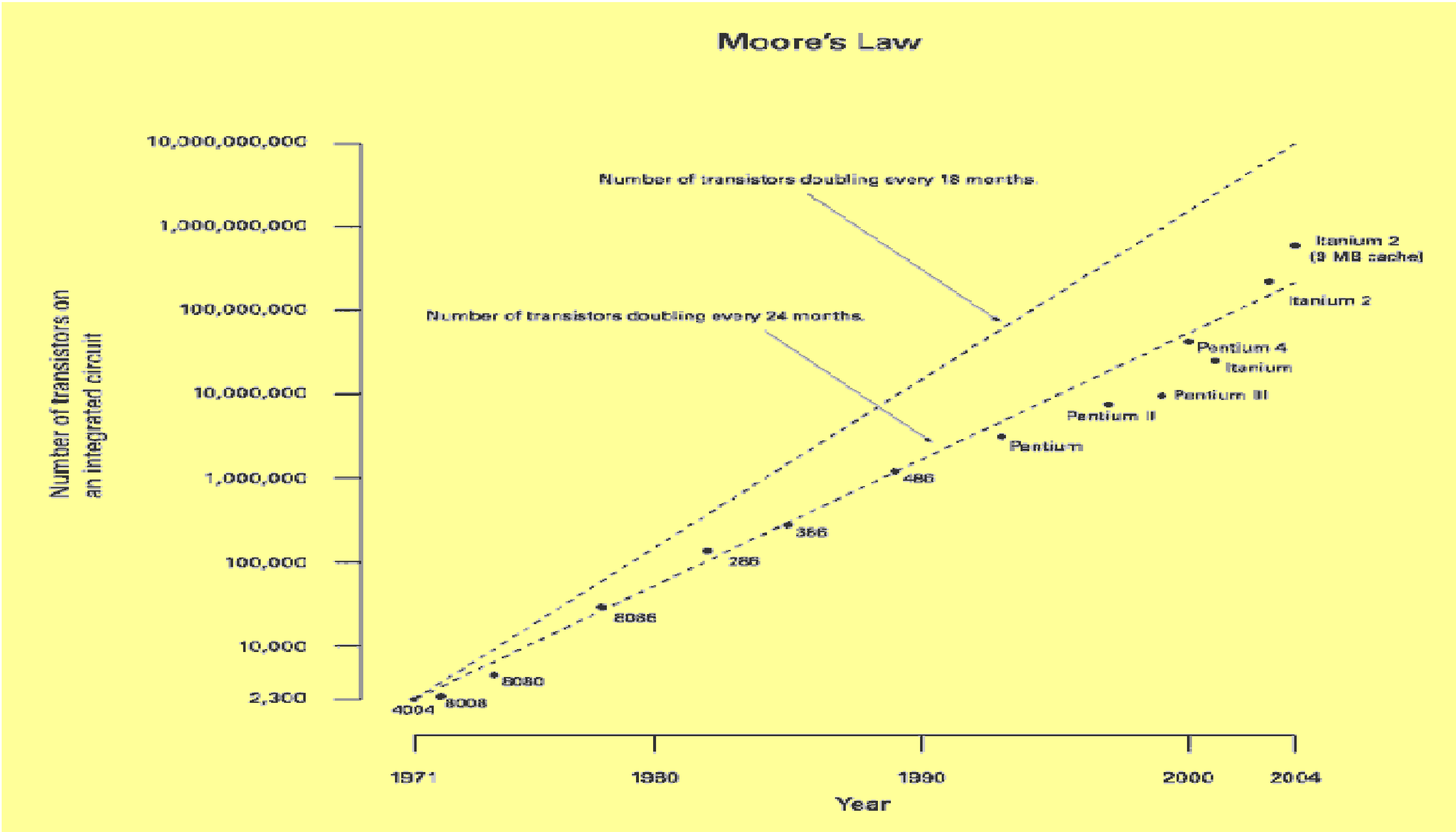
Greater Demand for Improvements in Project Performance

What Got us Where We Are
Won't Necessarily Get us Where We Need to Be!

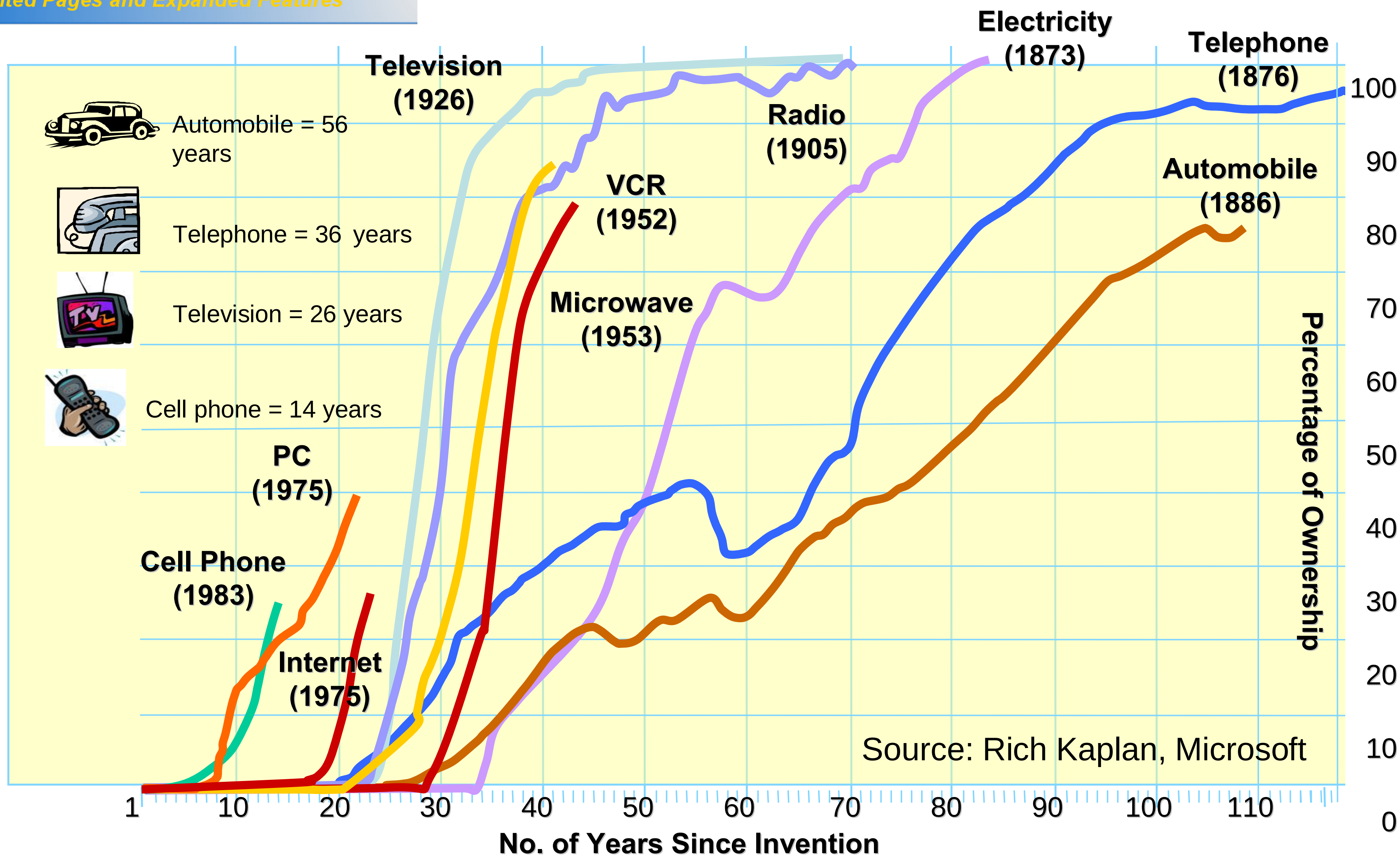
Acceleration of Innovation in the 21st Century - The Impact on Business and Society

Ref: Ray Kurtzweil

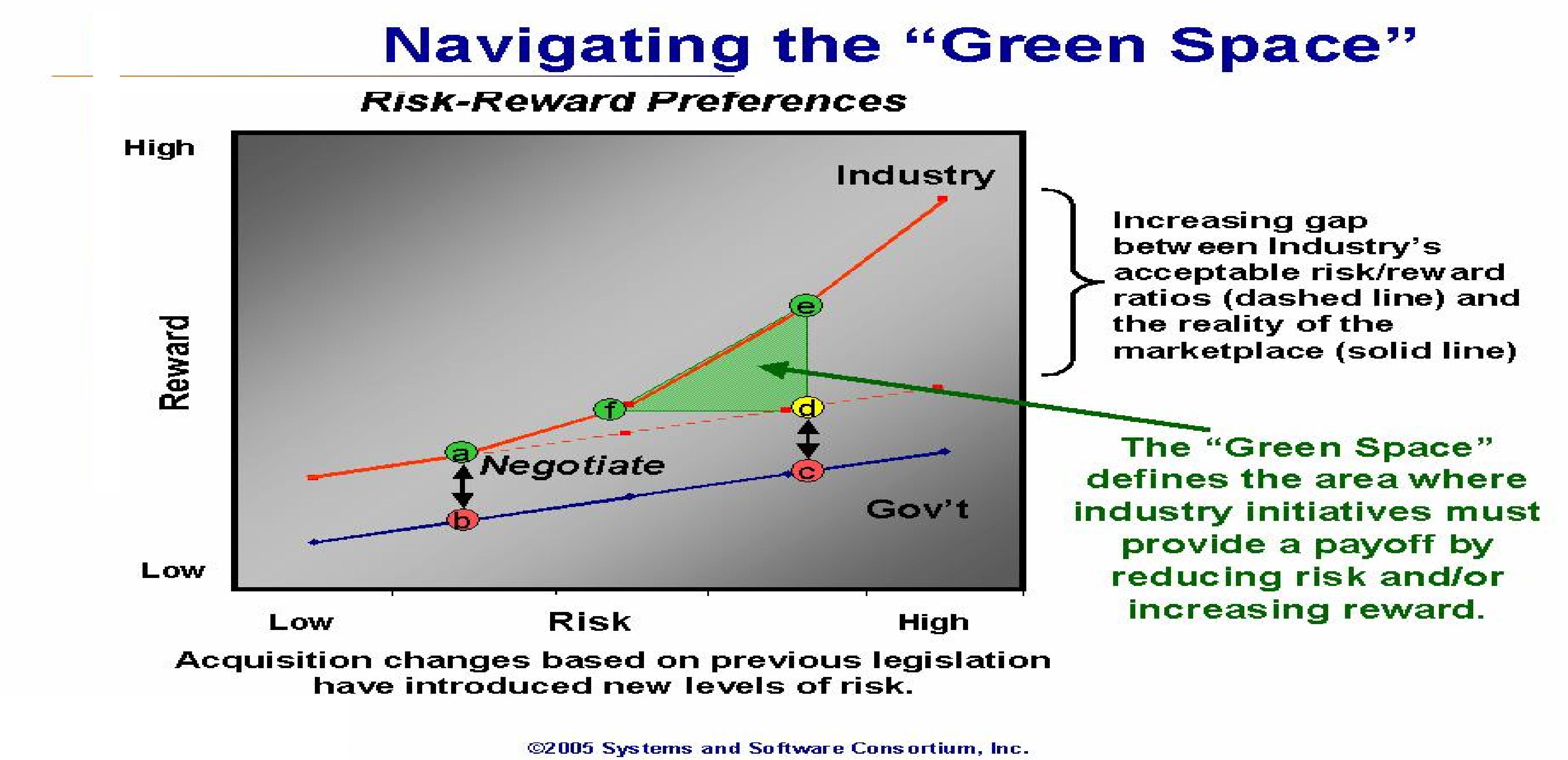
...ration: Moore's Law - The Number of ...n be Placed on an Integrated Circuit is Doubling Approximately Every Two Years



eration: Increased Technology Rate of



...Project Management (Especially the Acquirer) to ...tively Navigating the Green/Acquisition Space



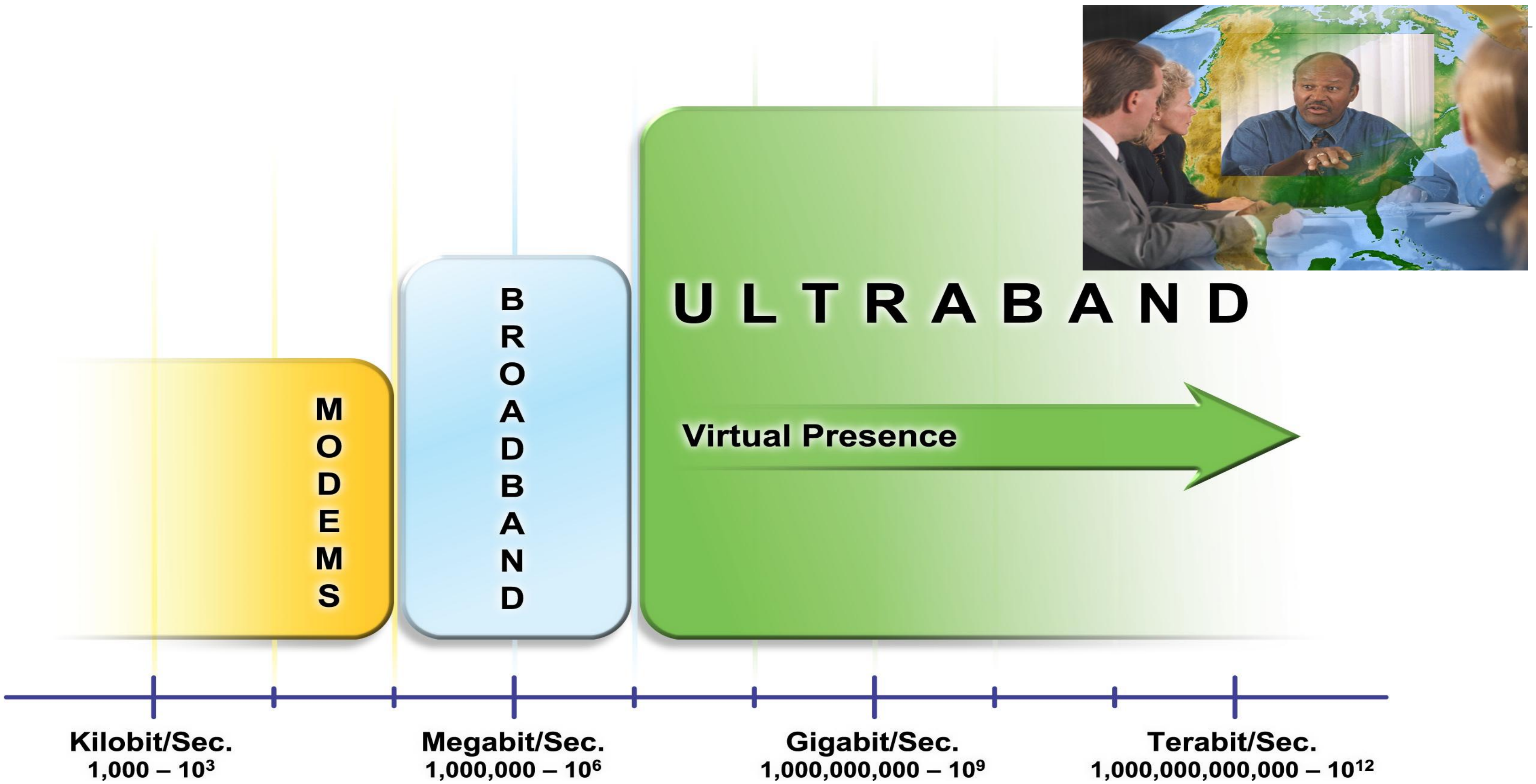
Source: Nidiffer and Dolan, IEEE Software, Sept/Oct 2005

isals and Maturity Levels EI by Country

Country	Number of Appraisals	Maturity Level 1 Reported	Maturity Level 2 Reported	Maturity Level 3 Reported	Maturity Level 4 Reported	Maturity Level 5 Reported
Argentina	19	No	Yes	Yes	Yes	Yes
Australia	23	Yes	Yes	Yes	Yes	Yes
Austria	10 or fewer					
Bahrain	10 or fewer					
Belarus	10 or fewer					
Belgium	10 or fewer					
Brazil	48	No	Yes	Yes	Yes	Yes
Canada	26	No	Yes	Yes	Yes	Yes
Chile	15	No	Yes	Yes	No	Yes
China	240	Yes	Yes	Yes	Yes	Yes
Colombia	10 or fewer					
Czech Republic	10 or fewer					
Denmark	10 or fewer					
Dominican Republic	10 or fewer					
Egypt	17	No	Yes	Yes	Yes	Yes
Finland	10 or fewer					
France	75	Yes	Yes	Yes	Yes	Yes
Germany	35	Yes	Yes	Yes	Yes	Yes
Hong Kong	10					
India	204	No	Yes	Yes	Yes	Yes
Indonesia	10 or fewer					
Ireland	10 or fewer					
Israel	10					
Italy	10 or fewer					
Japan	172	Yes	Yes	Yes	Yes	Yes

Country	Number of Appraisals	Maturity Level 1 Reported	Maturity Level 2 Reported	Maturity Level 3 Reported	Maturity Level 4 Reported	Maturity Level 5 Reported
Korea, Republic Of	78	Yes	Yes	Yes	Yes	Yes
Latvia	10 or fewer					
Malaysia	19	No	Yes	Yes	No	Yes
Mauritius	10 or fewer					
Mexico	15	No	Yes	Yes	Yes	Yes
Morocco	10 or fewer					
Netherlands	10 or fewer					
New Zealand	10 or fewer					
Pakistan	10 or fewer					
Peru	10 or fewer					
Philippines	16	No	Yes	Yes	No	Yes
Portugal	10 or fewer					
Russia	10 or fewer					
Singapore	10 or fewer					
Slovakia	10 or fewer					
South Africa	10 or fewer					
Spain	31	No	Yes	Yes	No	Yes
Sweden	10 or fewer					
Switzerland	10 or fewer					
Taiwan	46	No	Yes	Yes	No	Yes
Thailand	10 or fewer					
Turkey	10 or fewer					
United Kingdom	48	Yes	Yes	Yes	Yes	No
United States	718	Yes	Yes	Yes	Yes	Yes
Viet Nam	10 or fewer					

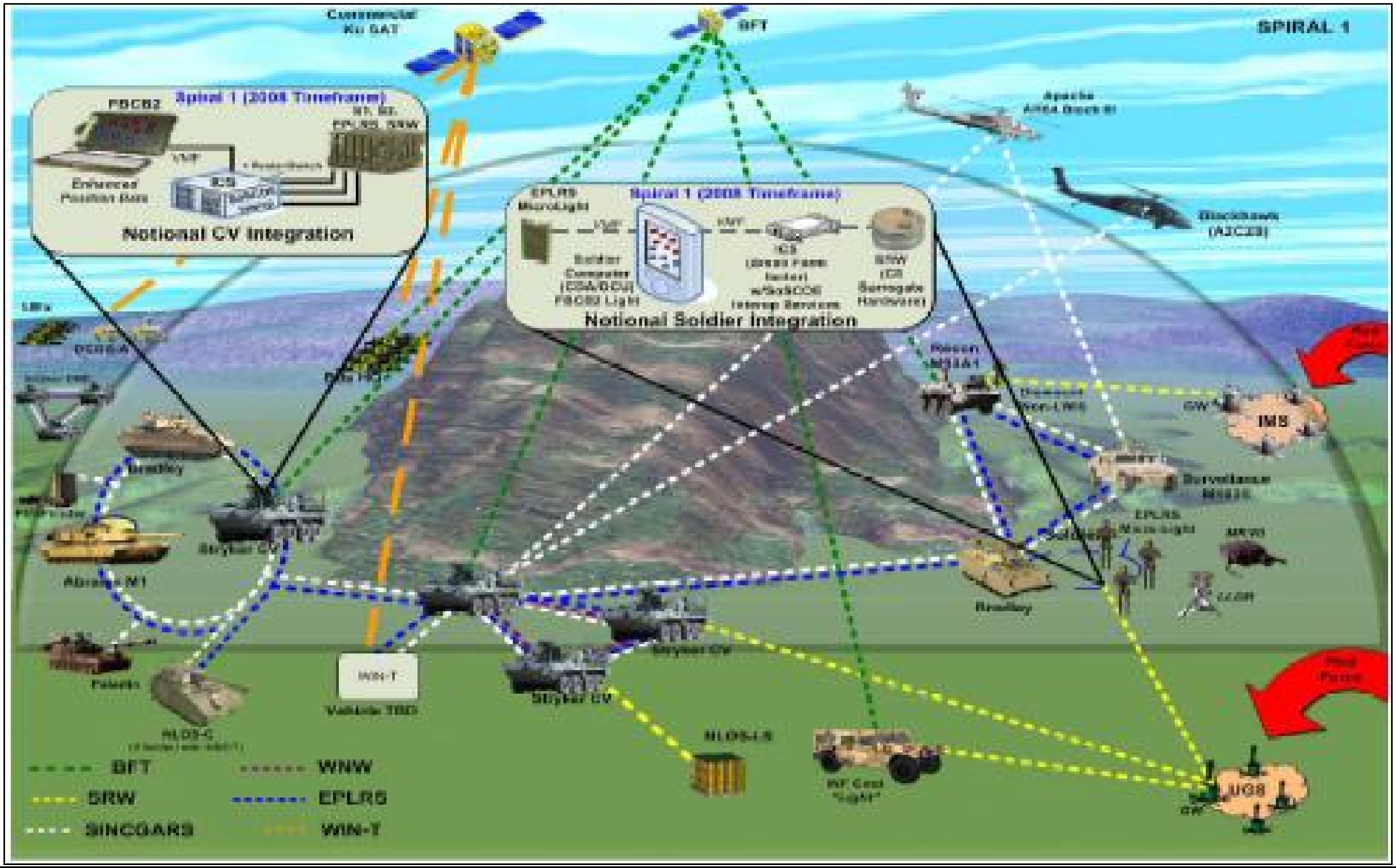
s in the Digital Spectrum Enables nmunication and Collaboration



Rule #4: The best companies are the best collaborators*

* Friedman, Thomas L. "*The World Is Flat*", Farrar, Straus and Giroux, 2005

…e Connects Systems…

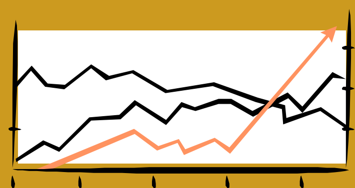


…e of Modeling and Simulation
…n Unveils New Modeling and Simulation Research Center

New Aviation Ship Integration Center, a state-of-the-art research facility established in partnership with the U.S. Navy to conduct modeling, simulation, research, development and in-depth analysis for CVN 21-class aircraft carriers and other aviation-capable ships.

Approaches to Process Improvement

Data-Driven (e.g., Six Sigma, Lean)



Clarify what your customer wants (Voice of Customer)

- Critical to Quality (CTQs)

Determine what your processes can do (Voice of Process)

- Statistical Process Control

Identify and prioritize improvement opportunities

- Causal analysis of data

Determine where your customers/competitors are going (Voice of Business)

- Design for Six Sigma

Model-Driven (e.g., CMMI)

Determine the industry best practice

- Benchmarking, models

Compare your current practices to the model

- Appraisal, education

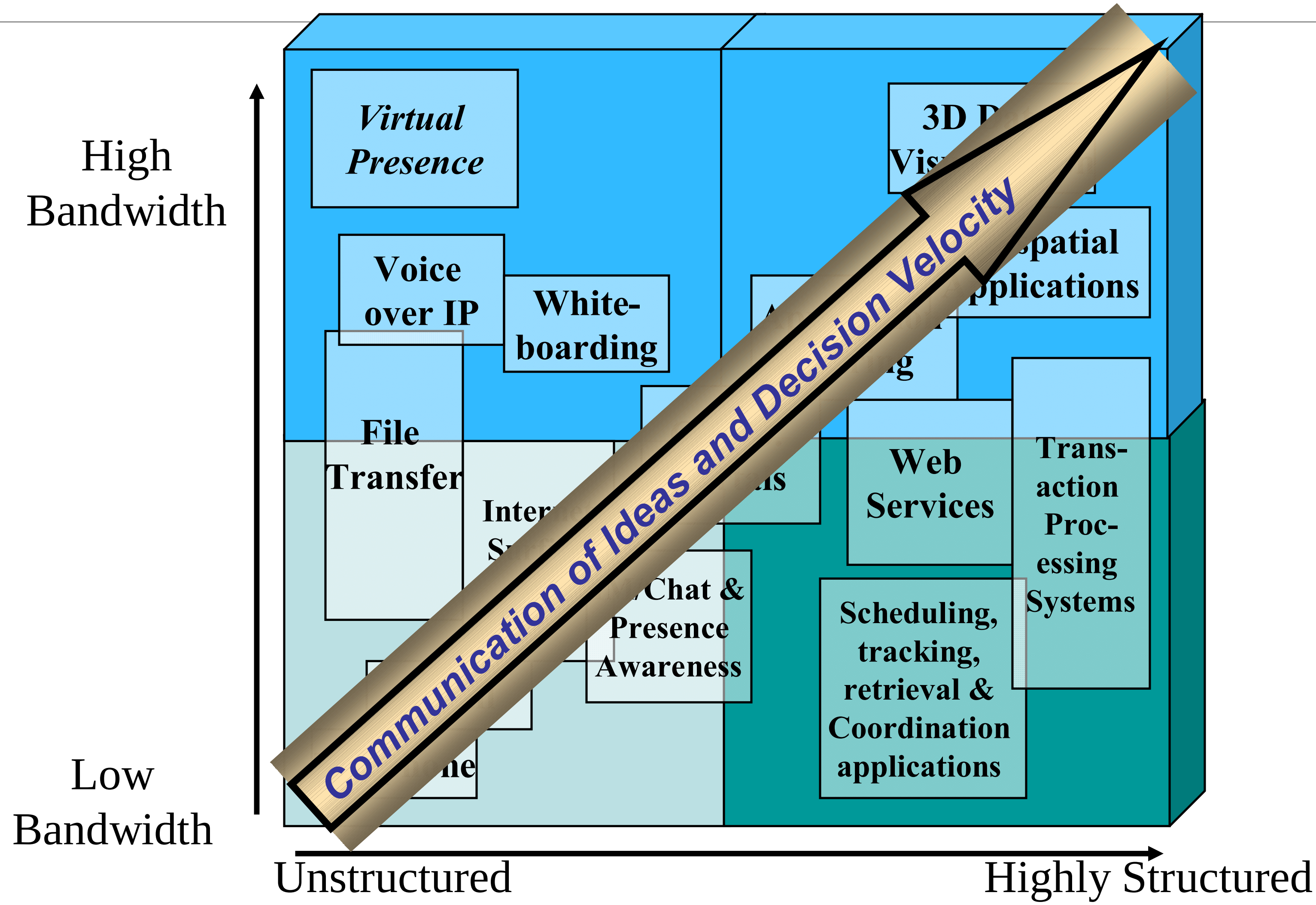
Identify and prioritize improvement opportunities

- Implementation
- Institutionalization

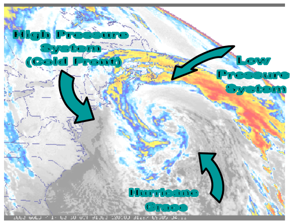
Look for ways to optimize the processes

Ref. Dr. Rick Hefner, Northrop Grumman

…vements in Collaboration Mechanisms …ystem Engineering Success



…are Engineering Trends That Bode Well for the Rapid Adoption of CMMI



Å*Greater demands on systems and software engineers will stimulate growth in the field – nationally and internationally*

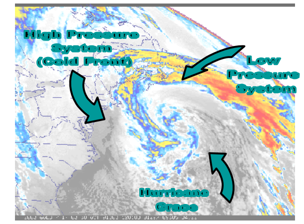
Å*Industry/Gov't will increasingly focus on attracting, training and retaining systems and software engineering talent – short and long run – with emphasis on providing a Generation Y work environment*

Å*Increased reliance on systems and software engineering processes and technologies to effectively manage the acquisition/"green" space*

Å*The laws of Augustine's and Moore will continue to hold and will continue to be a forcing function to bring the fields of software and systems engineering closer together*

Å*Improvements in program risk-reduction collaboration mechanisms will be significant enablers for increases in systems and software engineering communication and "decision velocity"*

...re Engineering Trends That Bode ...doption of CMMI



ÅIncreased need for a large number of complex systems and systems of systems will lead to investments in research and technology

ÅSystems and software engineers will continually find way to innovative to reduce complexity

- ï Increased importance of modeling and simulation
- ï Increased reliance on architectures (top-down and bottoms-up)
- ï Increased design for continuous evolution and deployment at all levels will occur
  - ➢ Understanding users and their context will evolve, e.g. leaner system and software engineering process assets on projects

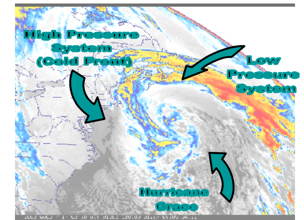
ÅIncreased customer requests for system and software engineering support earlier in life cycle

ÅShift of systems and software engineering focus from the platform to the networks

ÅProcess improvement will continue to be important


Questions?

eadings



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Integrated Implementation of Advanced Maturity Practices

Dale Childs
Defense Finance & Accounting Service

Agenda

- High Maturity Implementation
- High Maturity Foundation
- Practice Relationships
- Keys to Success

High Maturity Foundation

So

You achieved Maturity Level 3

Congratulations!!!!!

And now youôre ready for all that high maturity stuff

Really??????

High Maturity Foundation

Do lower Maturity Level PAs look, feel and smell differently in a High Maturity Organization????

YOU BETCHA!!!!!!!!!!!!!!!!!!!

They serve as the foundation for ML4 and ML5 practices

High Maturity Foundation

Maturity Level 5 PAs - A Qualitative Summary

CAR ï If something is wrong, or needs to be better, get the right people together, detemine the real problem, and fix it.

OID ï Try to get better ï especially in the areas that are most important. Be pro-active in looking for ways to get better in these important areas.

I'll bet you're already doing this!!!!

High Maturity Foundation

PPQA ï Are you performing trend analysis on non-compliance items?

PMC ï Are you determining the real cause of deviations from plans?

VER & VAL ï Are you performing trend analysis on issues arising from Peer Reviews?
Are you performing trend analysis and determining the real cause of problems found in T&E?

High Maturity Foundation

OPF ï How pro-active is your PI program? How do you prioritize PI initiatives? How do you know if improvements are really improvements?

MA ï What is the basis for those objectives? Do your measures really tie to the objectives? Are your operational definitions sound?

High Maturity Foundation

OPD ï Do you truly have a set of standard processes? Are the process elements well defined?

GP 3.2 ï Are you really collecting improvement information? Is it quantified?

How do you know if things are going well?

High Maturity Foundation

OPP

QPM

High Maturity Foundation

How do you establish Quality and Performance Baselines and Models without the data from QPM?

How do you establish the framework for QPM without OPP?

See High Maturity Foundation

(I vote for the chicken)

Practice Relationships

OPP SP 1.3 Establish quality and process performance objectives

- QPM SP 1.1 Establish the projectôs objectives
- OID SP 1.1 Collect and analyze improvement proposals
- OID SP 1.2 Identify and analyze innovations
- OID SP 1.4 Select improvements for deployment

Practice Relationships

OPP SP 1.4 Establish process-performance baselines
OPP SP 1.5 Establish process-performance models

- QPM SP 1.2 Compose the defined process (and most of QPM)
- OID SP 1.1 Collect and analyze improvement proposals
- OID SP 1.2 Identify and analyze innovations
- OID SP 2.3 Measure improvement effects

Practice Relationships

QPM SP 1.1 Establish the project's objectives

QPM SP 1.4 Manage project performance

QPM SP 2.3 Monitor performance of the selected subprocesses

CAR SP 1.1 Select data for analysis

Practice Relationships

QPM SP 1.2 Compose the defined process

QPM SP 1.4 Manage project performance

QPM SP 2.3 Monitor performance of the selected subprocesses

CAR SP 2.1 Implement the action proposals

CAR SP 2.2 Evaluate the effect of changes

Keys to Success

Common Misconceptions:

Processes vs Subprocesses

Subprocess ï a defined component of a larger defined process that may be decomposed further

ML4 statistical management is at this level

Process-performance models

The use of product and/or process measurements collected in one activity to predict the results of another activity

Example ï Defects found in a requirements Peer Review used to determine the number of defects that will be found in integration testing

Keys to Success

- Be sure of your foundation
- Keep it practical ï not academic
- Use the informative material
  - ML4 = special cause variation
  - ML5 = common cause variation
- Treat the 4 PAs as one
- Donôt be overly concerned with Project vs Org with CAR and OID activities
- Use qualified people and tools to develop process-performance models

Contact Information

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Thought Before Action:

The Advantage of High-Maturity Thinking in a Lower-Maturity Organization

Software Engineering Institute
Carnegie Mellon University
Pittsburgh, PA 15213

James D. McHale
CMMI NDIA 2007

Some Radical Thoughts

Fallacy: Any time spent on the higher maturity level practices while attempting to achieve CMMI ML2 or ML3 is, by definition, wasted effort.

Radical Thought #1: Any time spent implementing policies and practices at ML2 and ML3 that does not support the higher maturity level CMMI practices violates the intent of the model.

- Otherwise serious rework can be required to achieve ML4 and ML5.
- At the extreme, ML2 and ML3 practices are implemented poorly and for all the wrong reasons.

Radical Thought #2: You need to understand ML4 and ML5 concepts before you can properly interpret ML2 and ML3 for your organization.

mprovement?

The phrase ñprocess improvementòimplies improving the ***performance*** of a given process or set of processes with respect to some objective standard.

Å CMMI does not specify performance standards, it only implies their existence.

Improving performance with respect to an objective standard implies that something about the process will be measured.

"If you can not measure it, you can not improve it." ï Lord Kelvin

s Performance?

Process Performance: ñA measure of actual results achieved by following a process. It is characterized by both process measures (e.g., effort, cycle time, and defect removal efficiency) and product measures (e.g., reliability, defect density, and response time).ò

Process Performance Baseline [PPB]: ñA documented characterization of the actual results achieved by following a process, which is used as a benchmark for comparing actual process performance against expected process performance.ò

Process Performance Model [PPM]: ñA description of the relationships among attributes of a process and its work products that is developed from historical process-performance data and calibrated using collected process and product measures from the project and that is used to predict results to be achieved by following a process.ò

- from the CMMI Glossary

Performance Model?

A process performance model is used for essential process improvement activities.

- explain past performance (e.g. the PPBs)
- predict future performance (may look like the PPBs in part)
- indicate what (else) to measure
- identify opportunities for improvement

Are these purposes guiding *your* ML2 and ML3 practices?

Can you do these things without the statistical rigor demanded by ML4/5?

ine

In ***Mythical Man-Month***, Fred Brooks gave this gross characterization of effort distribution of programming processes.

Planning and design	1/3
Coding	1/6
Unit Test	1/4
System Test	1/4

This characterization provides a ***baseline*** (although not a complete PPB in the CMMI sense) for process performance at IBM in the late 1960s.

It can help to ***explain*** past process performance, and when combined with an estimate of effort on a future similar project, it can help to ***predict*** future performance of the process (although not yet a PPM).

and What’s Missing

Based on this historical benchmark, if I have an enhancement project that I estimate at 100 hours, my predicted performance would be:

Planning and design	33 hrs.
Coding	17 hrs.
Unit Test	25 hrs.
System Test	25 hrs.

Do I have any idea of how relevant this prediction is to me?

Do I have any idea of which activities have the most opportunity for improvement?

Do I have any idea of how to push this in the direction of a true PPM?

Project Data

Planning and Design	27 hrs.
Coding	38 hrs. (until clean compile)
Unit Test	38 hrs. (21 defects found)
System Test	35 hrs. (11 defects found, 3 passes of test suite)
Total	138 hrs. (vs. estimated 100 hrs.)

Do I have any idea of how ñnormalò this may or may not be for me?

What should I be measuring in more detail on future projects?

s I Want to Know

How much time in planning vs. design vs. understanding requirements?

How much time fixing compile/environmental defects?

How many unit test cases? How many passes (partial and complete)?

How much time executing system test suite vs. fixing defects?

rovement Proposal (PIP #1)

Process problems:

1. No way to tell from the gathered data how much time was spent on planning vs. design or other activities in that phase
2. No way to tell how much time in coding was in fixing compile or link defects
3. How much test time in testing vs. fixing

Proposed solutions:

1. Tag all hours with óplanningô, ódesignô, óanalysisô, óotherô
2. Tag all hours in coding with ócodeô or ócompile/fixô
3. Tag all hours in test with ótesting <case #>ô or ódefect find/fix <bug #>ô

ugh analysis

After a couple more similar projects:

Phase	Project 1	Project 2	Project 3	Cum. %
Planning & design	27	38	47	25.8
Code	38	26	39	23.5
Unit Test	38	28	43	25.2
System Test	35	29	47	25.5
Totals ï Act./Est.	138 / 100	122 / 110	175 / 120	100.0

From hour tags, understanding requirements is about 1/2 of ñplanning and designò time, actual planning and design about 1/4 each.

Defect fix times in UT and ST are about 70-80% of the total test time, more if you count all of the extra passes needed in the test suites.

alysis continued

On average, the phases are fairly equally balanced.

However, looking at individual efforts for ñplanning and designò as a predictor, those were much different (about 1/5, 1/3, 1/4, respectively).

Prediction of the cumulative time measured after ñcodingò seems much more reliable, always about 1/2 the total project time in ñplanning & designò and ñcodingò, the other half in ñunit testò and ñsystem testò.

ñUnit testò is a fairly good predictor of ñsystem testò, even though the tests run are completely different.

Estimates arenôt very good (about 30% average overrun). If only we didnôt have to do ñsystem testòé

Characterizing key relationships and their variation statistically helps to make a PPM.

Process problems:

1. Many defects and multiple test suite passes (waste of time!) are due to not being able to find all defects in the first pass.
2. Effort overruns are creating increased project tracking overhead (i.e. management pressure).

Proposed solutions:

1. Provide inspection training & require inspections of all code; log all inspection effort and defect data.
2. Increase effort estimates by an amount large enough to allow for variation in key performance indicators.

...spections

Phase	Project 4	Project 5	Project 6	Cum %
Planning & design	20	40	40	22.9
Coding	25	45	75	33.2
Unit Test	21	33	37	22.2
System Test	24	30	32	21.7
Totals ï Act./Est.	95 / 75	148 / 185	184 / 215	100.0

Inspection time was rolled into ñcodingò since it is the code being inspected, about 1/4 of the total ñcodingò effort.

UT and ST about 42% of total effort, down from about 51%.

Actuals are about 11% under estimates on average, but they would have been about 18-19% over if not for 1/3 ñeffort adjustmentò.

ata Analysis / More Questions?

On this basis (18-19% vs. 30+% over), inspections seem to be working. (Remember to compare apples to apples!)

Defects found in code inspection tend to be simple coding errors, with the occasional design defect.

About 60% of total testing effort still devoted to finding defects and multiple test suite runs. A majority of defects now seem to be design issues (used to be about even between design and coding issues).

ships

ñPlanning and designòand ñcodingòeffort seem to relate directly to the scope of the project.

E1 (effort before test) = ***f***(scope)

While loosely related to scope, testing effort seems more directly related to the number of defects and the number of test suite passes.

E2 (effort in test) = ***f***(defects) + (effort in 1 pass through UT and ST)*

* - probably related to scope!

Problem description:

1. Effort estimates under management pressure
2. Still lots of ñwastedò time in UT and ST

Process proposal:

1. Reduce the 1/3 ñeffort adjustmentò to 1/5
2. Create more ñinspectableò designs by using design templates or architectural views; inspect for common design defects found in test

Note: Is either proposal ñstatistically soundò? (Probably not.)

What would you do instead? (Hmmmé é .)

Rhetorical Questions

Is the gathering and use of data *by the people doing the job* high- or low-maturity?

Do I have to be ML4 or ML5 to do any of this?

Will this *make* you ML4 or ML5 (or any level) if you do this?

Have you seen control charts? Complex mathematical models?

Do you think that such practices would help speed you on your way to ML4/5?

Requirements (Constraints)

The Voice of the Business (your boss) tells you that your performance goal for next year is to deliver your projects in 85% of the calendar time that you estimate with fewer defects delivered to the external customer.

Your standard process simply cannot perform to this level.

There are two basic types of response to such pressure.

- low maturity (try harder! i.e. more than 40 hours/week)
- high maturity (work smarter!)

rity Response -1

Your current process baseline (still not a PPB) looks like this:

<table>
<tr><th>Phase</th><th>% actual effort</th><th>Defect yield*</th><th>Notes</th></tr>
<tr><td>Planning and design</td><td>30</td><td>40%</td><td rowspan="4">Based on defects reported from the field.

Early yields are from inspections.

Single pass of UT and ST ~10% of effort.</td></tr>
<tr><td>Coding</td><td>35</td><td>50%</td></tr>
<tr><td>Unit Test</td><td>15</td><td>40%</td></tr>
<tr><td>System Test</td><td>20</td><td>40%</td></tr>
</table>

You need to squeeze 15% out of your average estimated lifecycle effort.

You are still doing multiple passes of extensive (and expensive) testing.

If only you could reduce the number of passes in UT and STé

* Defect yield ï percentage of defects found in phase that were present or injected in that phase

y Response -2

If you could increase yields in the early phases, you could further reduce the number of defects in UT and ST and, more significantly, finally reduce the number of test passes.

You canôt wave a magic wand at inspections and say, ñFind more defects!ò

But youôve heard or read of other methods that drastically reduce the numbers of test defects.

Å PSP/TSP

Å Correctness by Construction

Å Test-Driven Development

Pick one. Investigate. Better yet, get your process group to do it! Or at least pay for the training. (But donôt tell them itôs the ML5 thing to do, it might scare themé)

-Independent) Thoughts

Process is like exercise.

If you aren't used to it, it hurts.

Once you do get used to it, if it still hurts, you are either

- trying to do too much
- doing it wrong

It gives you more time and energy to do all the other stuff you know you ought to be doing, so you get more done.

It's usually a little easier and a lot more fun when performed in groups.

emember

CMMI is a model that encourages (and ultimately demands) process performance improvement.

While it won't get you a ML4/ML5 rating, you can *begin* implementation of high-maturity concepts with very simple models and techniques. (Let the data show the way!)

Significantly improved performance on your projects is achievable now, regardless of maturity level.

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Software Engineering Institute | Carnegie Mellon

NORTHROP GRUMMAN
DEFINING THE FUTURE

Process Performance Baselines and Models: Duh, I Don’t Get It

CMMI Conference 2007
November 12 - 15, 2007

Diane Mizukami (Williams)
Diane.Mizukami@ngc.com
Northrop Grumman Corporation

- Knowing your goals
- Collecting data
- When do you have a baseline
- What is a model

nce

- Intended for people who are new to baselines and models.
- Uses an example that everyone can relate to,... how much time should I allocate to get to the airport gate on time.
- If you understand basic principles, you can apply it to your work.
- The bottom left corner of each slide describes how the same principles can be applied to peer reviews.

oals, i.e., What is Important to You?

Goal 1

(focus for this presentation)

Save every minute possible so I can spend more time at home instead of sitting in an airport.

Cost and schedule,… sound familiar?

Goal 2

Save money. There are different ways to get to the airport that have different costs.

Never create a baseline and model if you have no goal.

Peer Reviews: Typical peer review goals are to find more defects and to be more efficient.

Pain Sitting at the Airport?

Peer Reviews: Pain is the number of defects found during integration and test and system test.

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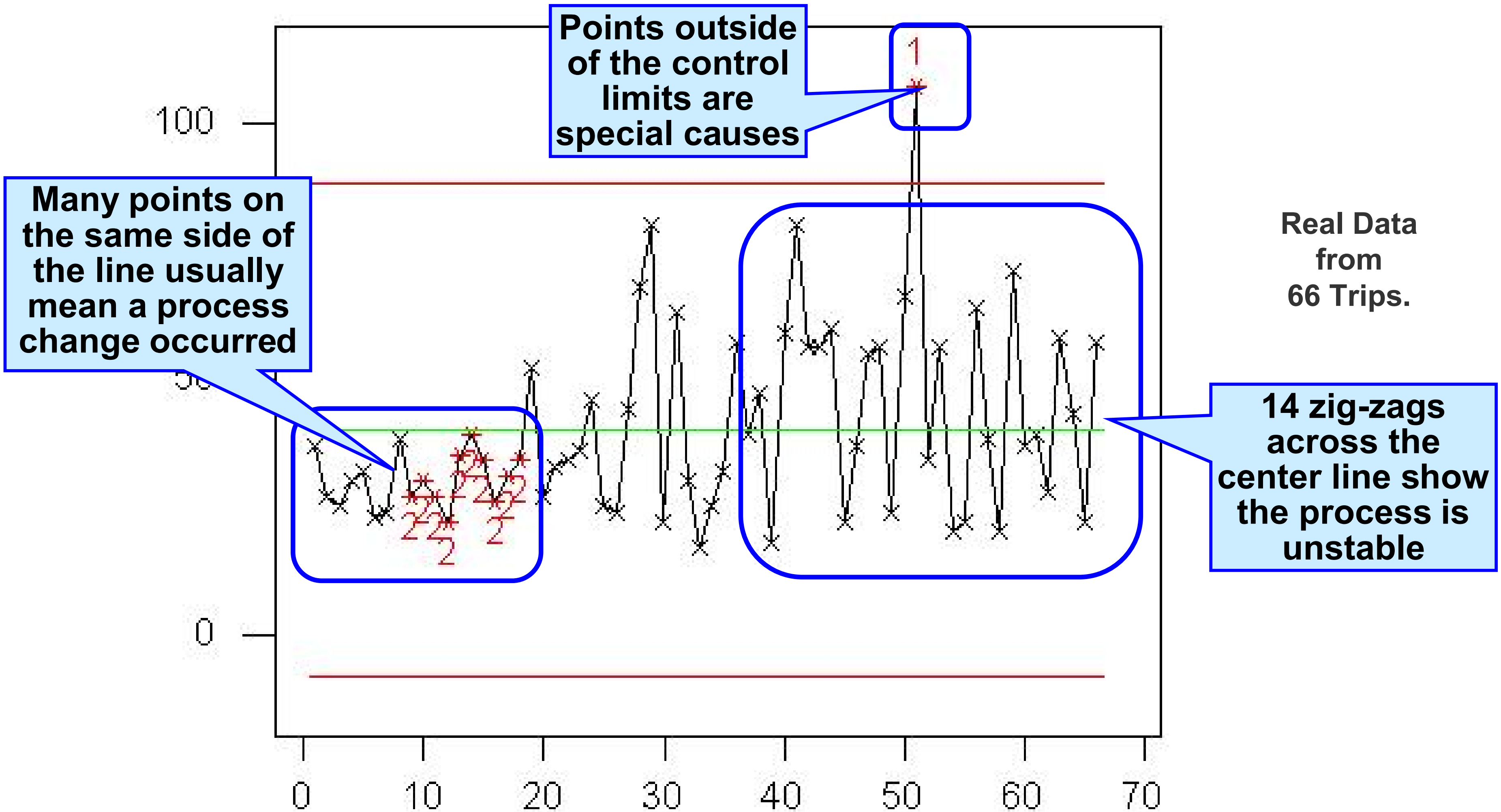
l Use a Stable Process



Real Data from 66 Trips.

Data is too unstable in many ways to establish a baseline.

Peer Reviews: At first, you might have the number of defects over the project life cycle so the process may be unstable.

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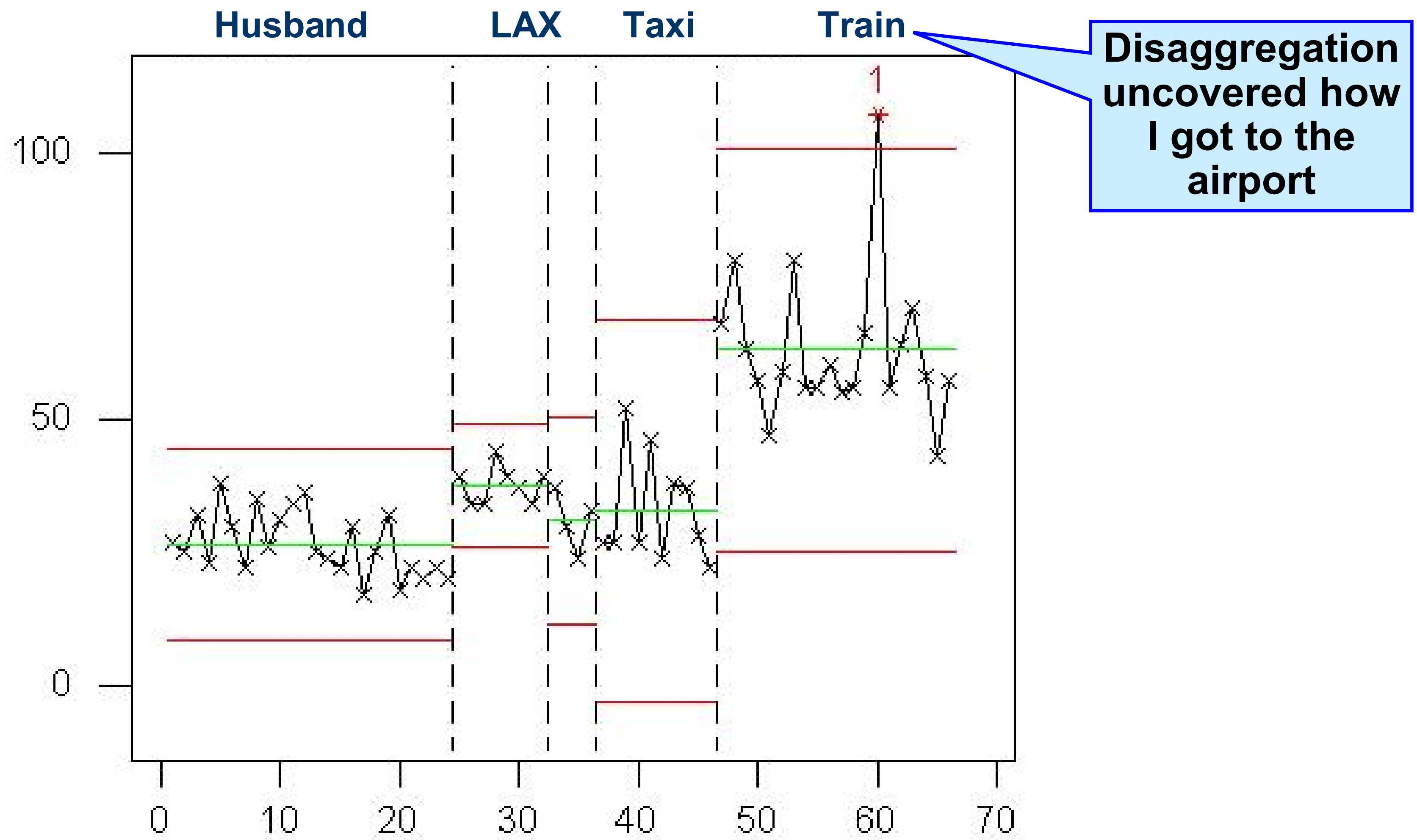
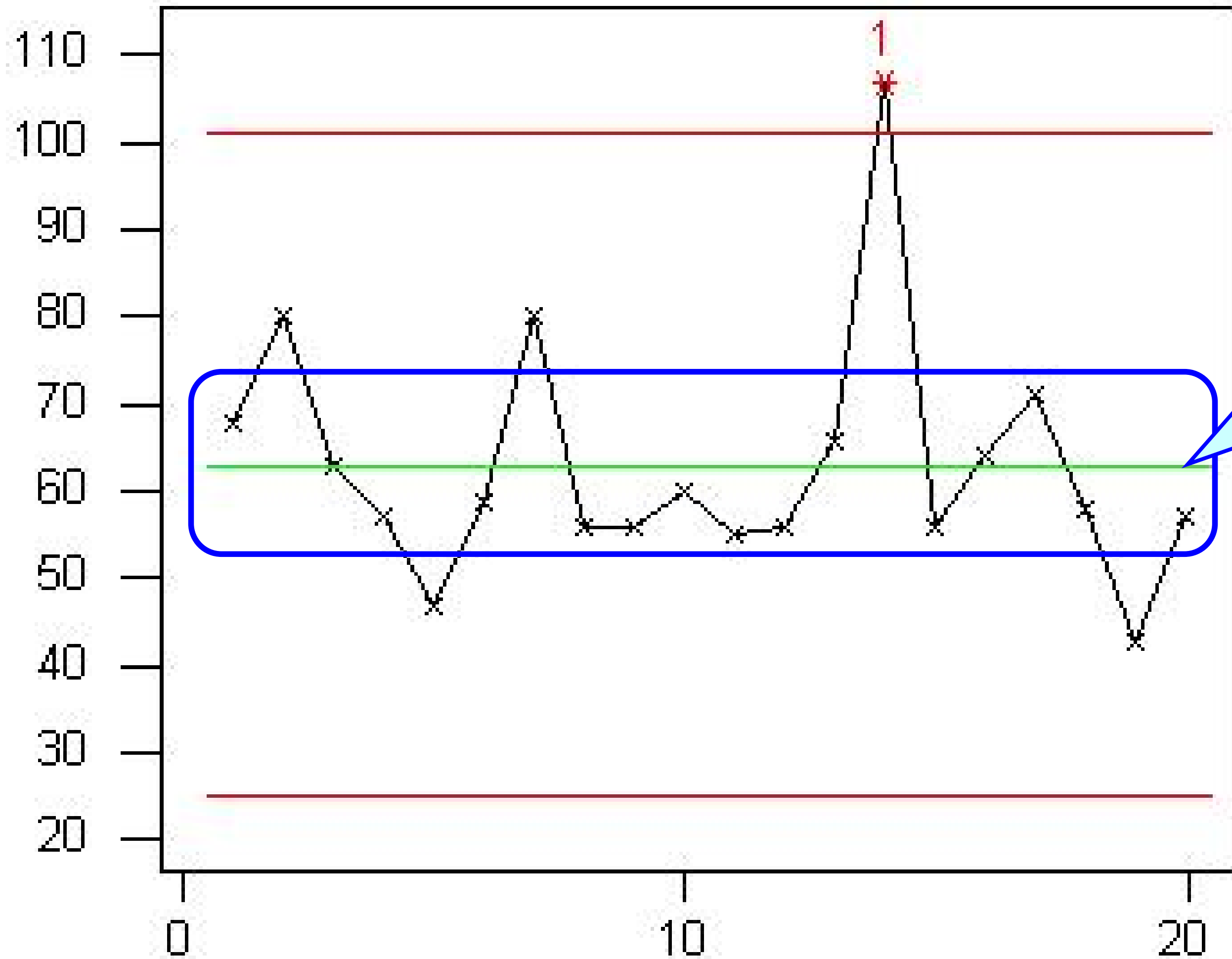
eally Unstable?



Disaggregation shows the data is actually more stable.

Peer Reviews: Breaking down the data by life-cycle phase, i.e., requirements, design, code, test, etc. may show the data is not unstable.

r Taking the Train



The data looks suspicious with most points near the mean. Probably an unstable process. Only 5 points out of 20 are not near the mean.

Disaggregate to see if there is a reason for the 5 outliers.

Peer Reviews: You might do a control chart of just code reviews and you might get some outliers.

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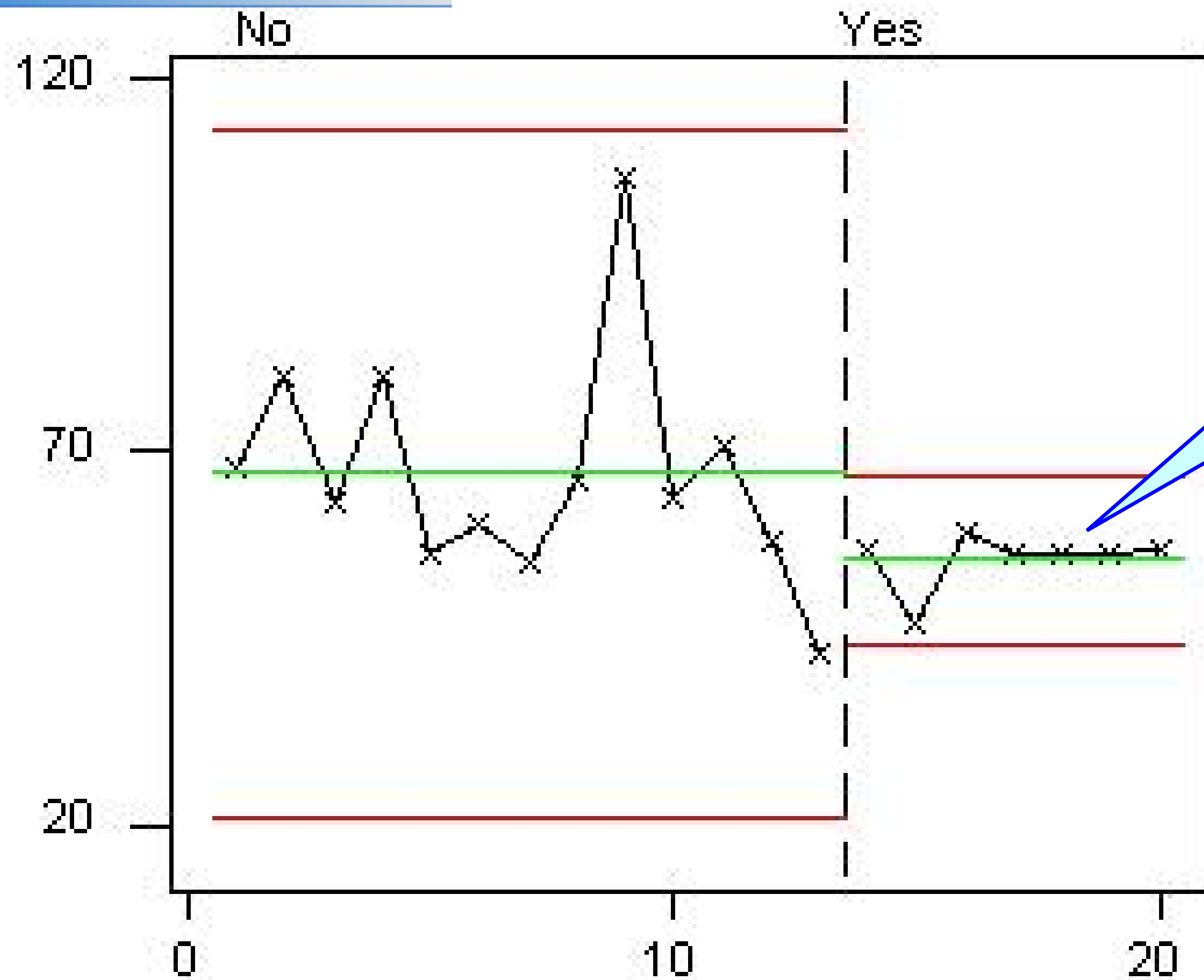
ons is Rush Hour

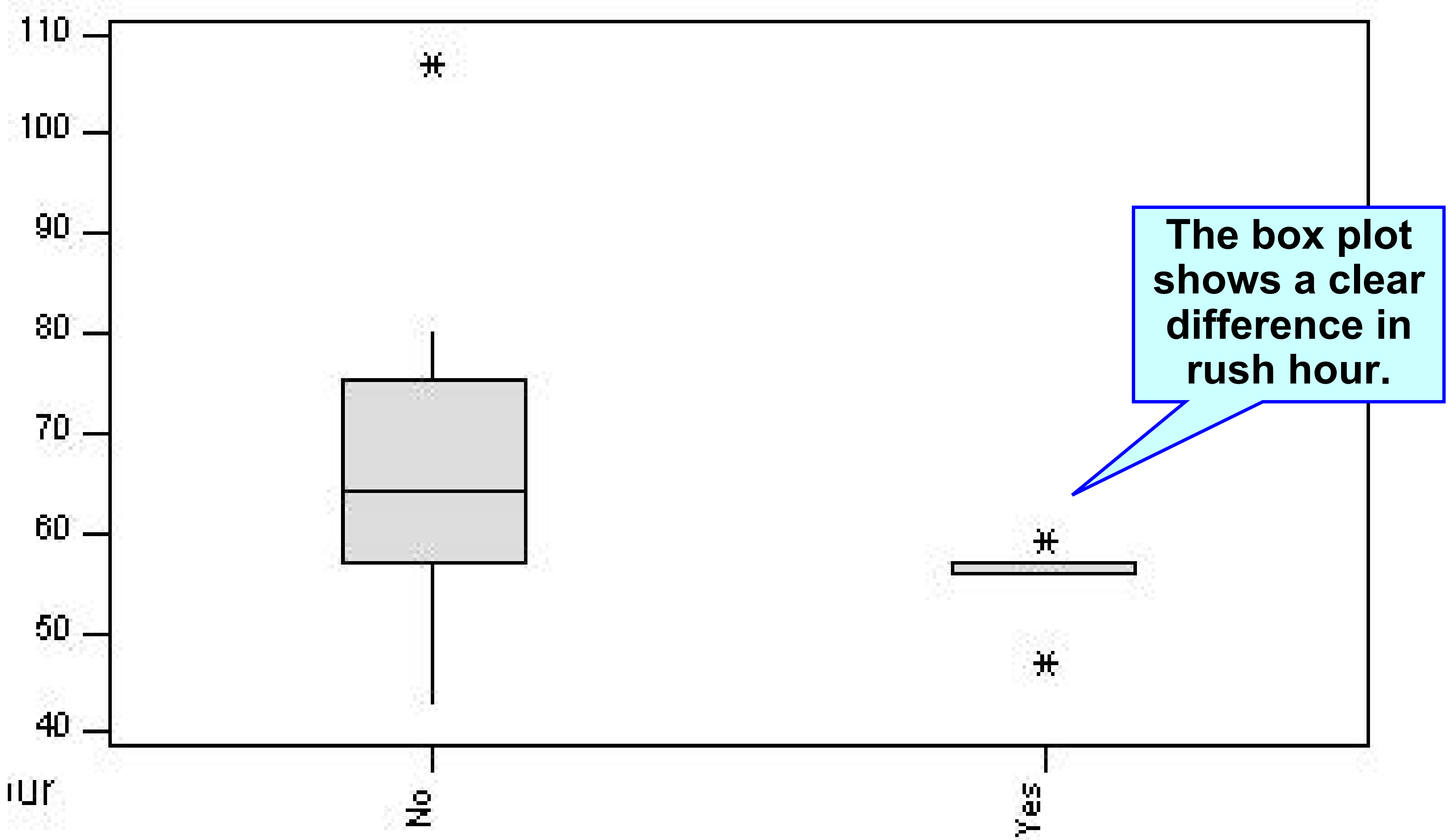


The best time to take the train is during rush hour.

Disaggregation helps to understand process variation.

Peer Reviews: An outlier could be complex code, an inexperienced developer, an unusually large number of reviewers, etc.

ence in Rush Hour Significant?



But is the difference significant enough to have two baselines?

Peer Reviews: Defects may be different for inexperienced developers but it may not be significant, whereas # of reviewers might be.

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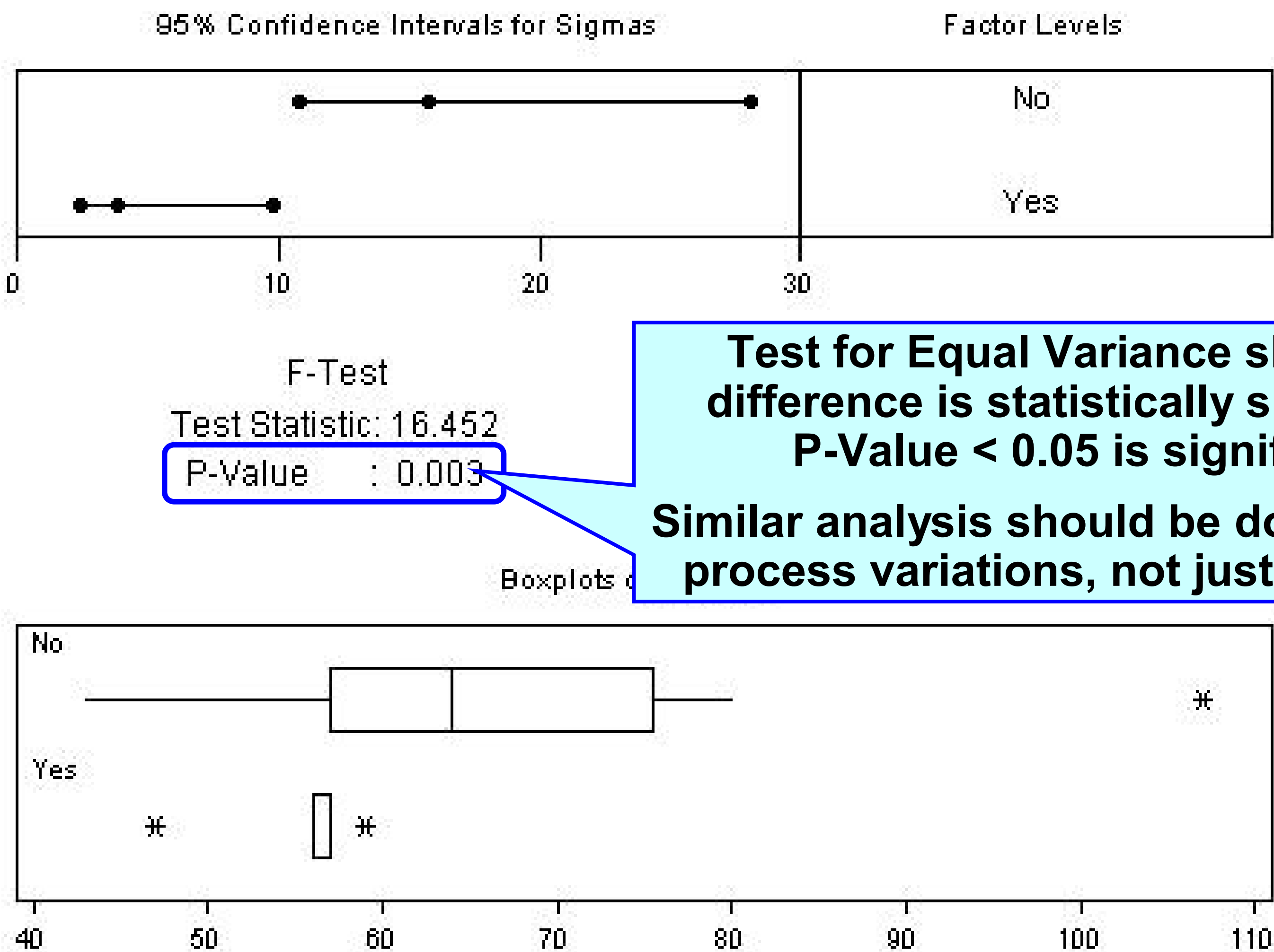
...riance Provides the Answer



Test for Equal Variance shows the difference is statistically significant. P-Value < 0.05 is significant.

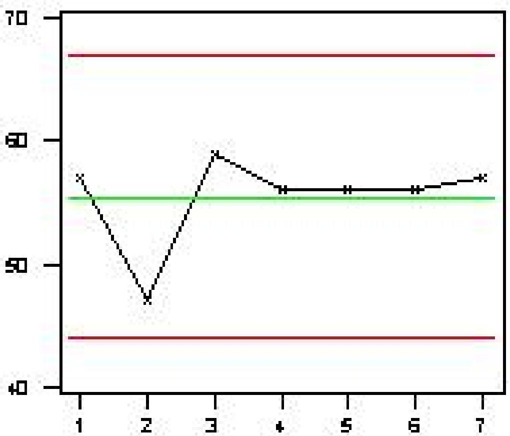
Similar analysis should be done for other process variations, not just rush hour.

The difference is significant enough to warrant two baselines.

Peer Reviews: One area that has a significant difference is whether people review thoroughly before the meeting.

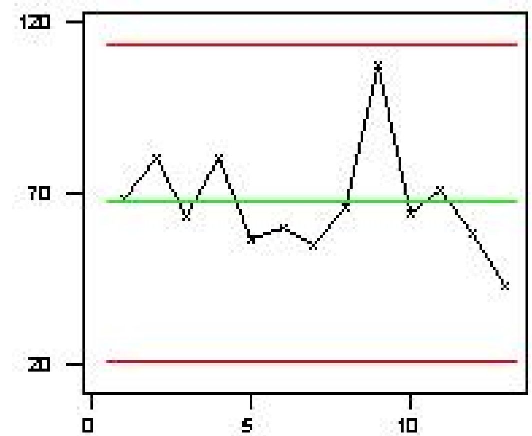
stablished for Rush Hour

Rush Hour Baseline



Mean	55.4286
StDev	3.8668
Variance	14.9524
Skewness	-2.19901
Kurtosis	5.49992
N	7
Minimum	47.0000
1st Quartile	56.0000
Median	56.0000
3rd Quartile	57.0000
Maximum	59.0000

Not Rush Hour Baseline



Mean	67.0000
StDev	15.6844
Variance	246
Skewness	1.28677
Kurtosis	2.89383
N	13
Minimum	43.000
1st Quartile	57.000
Median	64.000
3rd Quartile	75.500
Maximum	107.000

The standard deviation is high. Consider lower-level baselines to refine this baseline.

Note: Collect at least 15 points.

Baselines provide a range and distribution for performance.

Peer Reviews: The project may have separate baselines for peer reviews done with and without customers and managers.

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Need to Be Collected?

Actual data collection form used during train trips. Data was collected over the last 2.5 years for 17 trips.

Subprocess Step

1	Home to Train		Time leave house
2	Waiting for Train		Time sit on bench at train station
3	Train Ride		Time train leaves
4	Waiting for Shuttle		Time train stops at Aviation
5	Shuttle Ride		Time shuttle leaves
6	Terminal 1 to Terminal 6		Time shuttle at Terminal 1
7	Terminal 6 Door to Gate		Time at Door C at Terminal 6
			Time at United gate

Break down the process into measurable subprocesses.

Peer Reviews: Subprocesses for peer reviews include preparing, reviewing before the meeting, the meeting, closing action items.

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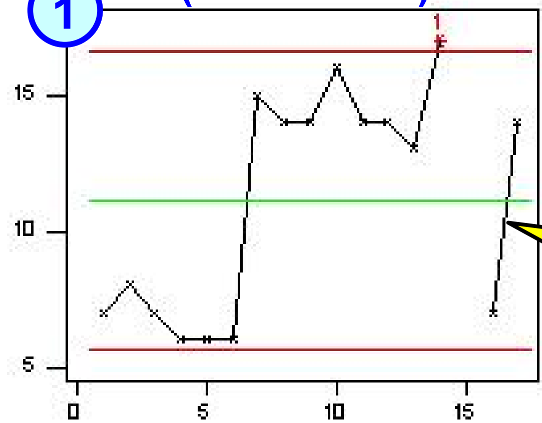
ocesses for Process Variation (1 of 2)

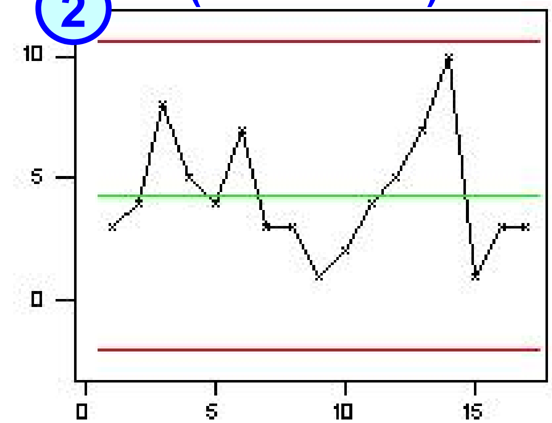
Home to Train (6 to 17 min)

1



Waiting for Train (1 to 10 min)

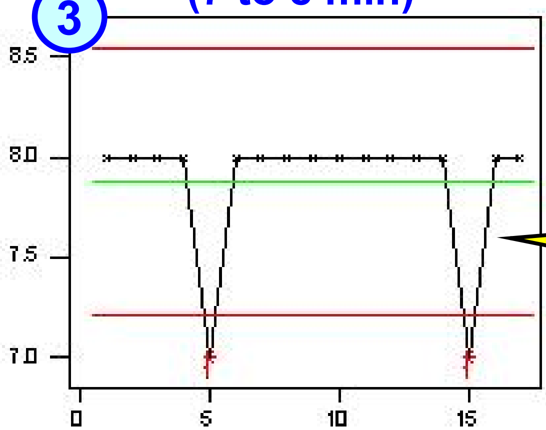
2



The distribution / range is unacceptable for 1 and 4. Need to understand better.

Train Ride (7 to 8 min)

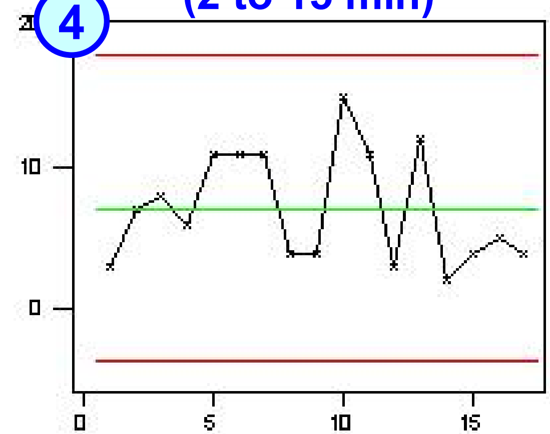
3



Train Ride is extremely stable. No improvements possible.

Waiting for Shuttle (2 to 15 min)

4



If youôre unhappy with the range, investigate for improvements.

Peer Reviews: Probably see variation depending on the number of reviewers and the size of the product being reviewed.

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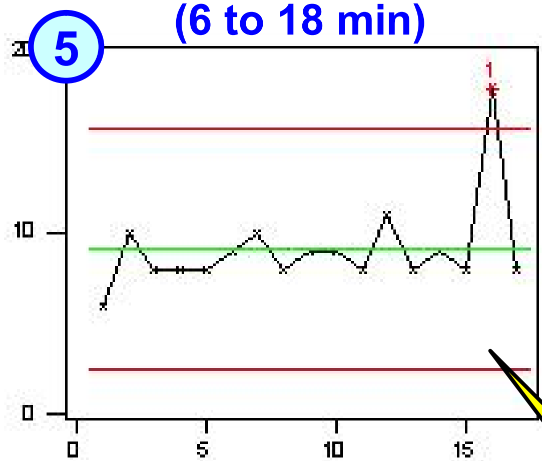
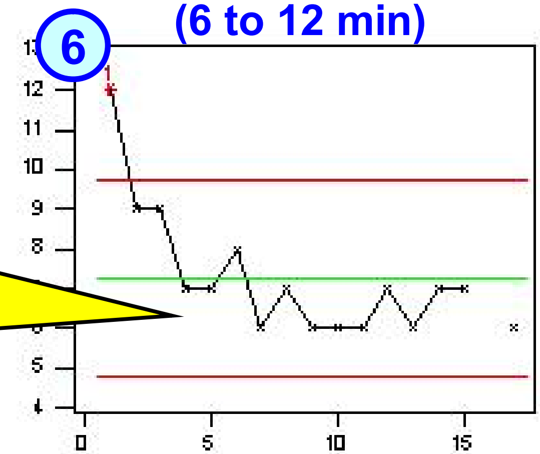
ocesses for Process Variation (2 of 2)

Shuttle Ride
(6 to 18 min)

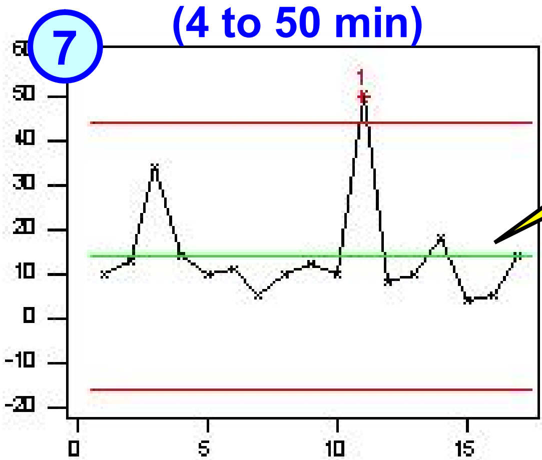


Terminal 1 to Terminal 6
(6 to 12 min)



Obvious the process was improved. Discovered it is faster to get off the shuttle and walk to Terminal 6.

Terminal 6 Door to Gate
(4 to 50 min)



5 and 7 appear stable but both have outliers to investigate

Outliers are special causes which should be investigated.

Peer Reviews: Variation in preparing for a meeting could be whether the customer is there, in which case briefings are created.

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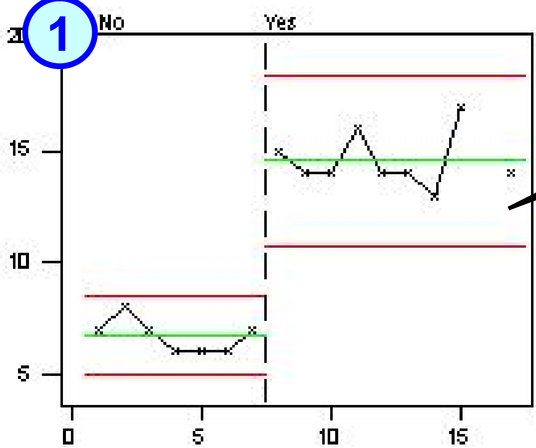
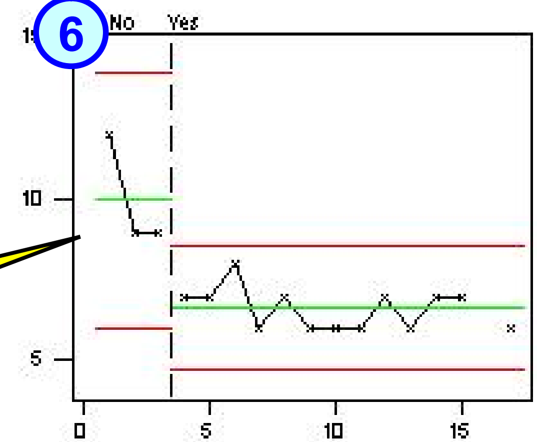
red Reasons for Process Variation

Home to Train



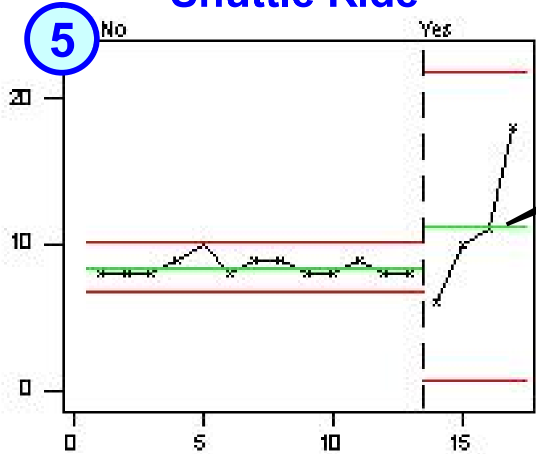
Terminal 1 to Terminal 6



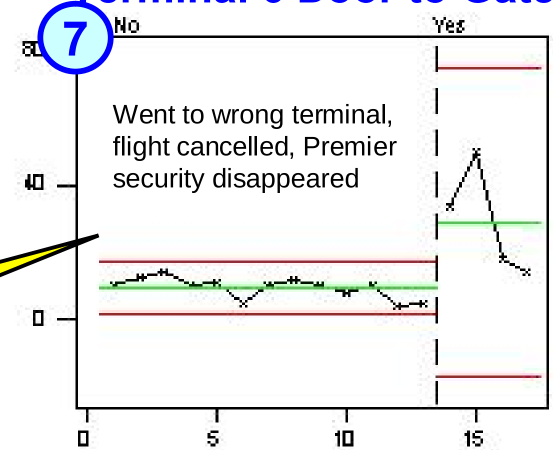
Driving vs Walking

Shuttle vs Walking

Shuttle Ride



Terminal 6 Door to Gate



Rush Hour vs No Rush Hour

Normal vs Special Case

Recall from previous slides about significant differences.

Peer Reviews: Collect enough data from each peer review subprocess so the graphs clearly show the difference.

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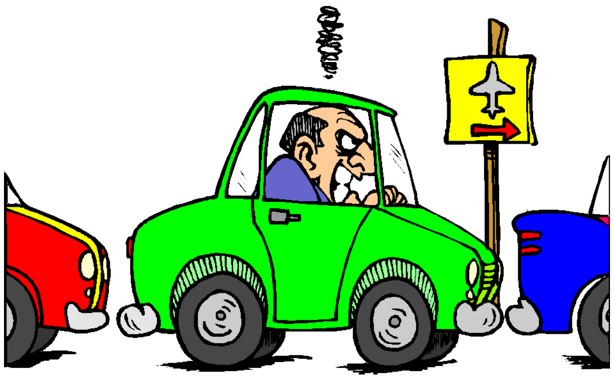
red 3 Variables for the Model

1 **Rush Hour**
(No translation needed)

2 **Raining**
(Translated for walking to the train and Terminal 6)

3 **Normal Situation**
(Translated for special causes)



Use terms that users of the model will understand.

Peer Reviews: This is not really a problem for peer reviews, except maybe ñinexperienced developeròwhich may be sensitive.

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Carlo Simulation

	Minimum Minutes	Median Minutes	Maximum Minutes	Mean	Standard Deviation	Monte Carlo Data Type
Train Details for Monte Carlo Simulation						
Home to Train (Car)	6	7	8			Triangular
Home to Train (Walk)				14.60	1.24	Lognormal
Wait for Train	1	3	5			Triangular
Train Ride	8	8	9			Triangular
Wait for Shuttle (Rush Hour)	3	4	7			Triangular
Wait for Shuttle (No Rush Hour)	2	8	16			Triangular
Shuttle Ride (Rush Hour)	6	11	18			Triangular
Shuttle Ride (No Rush Hour)	8	8	10			Triangular
Terminal 1 to United (Shuttle)	9	10	12			Triangular
Terminal 1 to United (Walk)	6	7	8			Triangular
To Gate (Special Cause)	14	30	50			Triangular
To Gate (Normal)				9.39	3.10	Normal
Variables for the Simulation						
Rush Hour?	Yes					
Raining?	No					
Normal Situation?	Yes					

3 variables for the simulation

Need to know whether Triangular, Normal, Lognormal, or a constant should be used for the simulation

Simulations assume you understand your data.

Peer Reviews: Can simulate the estimated number of defects, the estimated hours for doing peer reviews, etc.

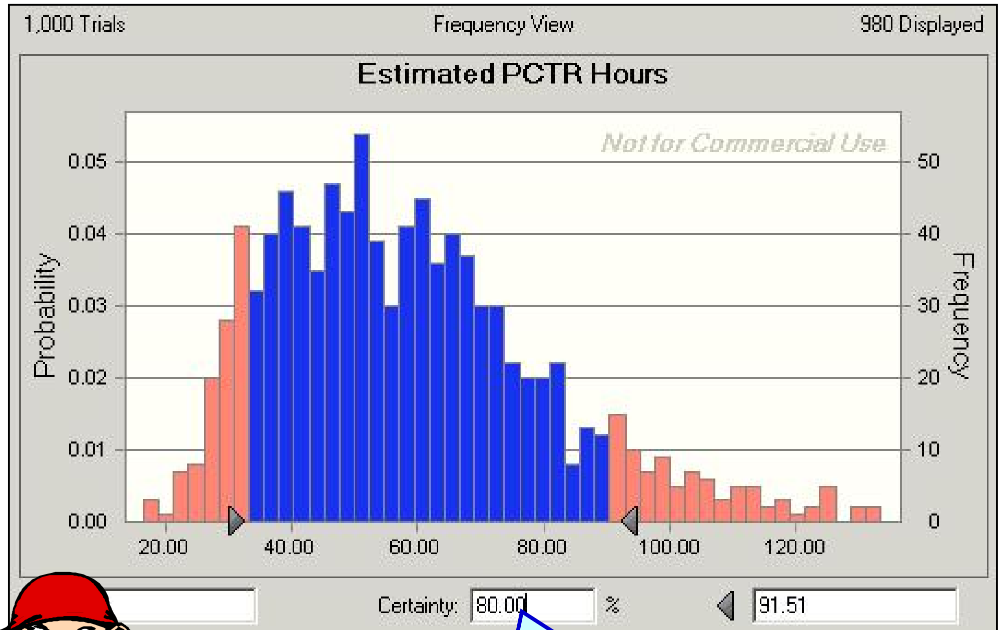
Train Trips

This is the actual model I use when I take the train. Based on the baselines, it says what time to leave the house.

Enter Departure Time:			8:20 AM
Look at Minimum Train Time:			6:55 AM
Enter Best Train Departure Time:			6:53 AM
Rush Hour (Yes or No):			Yes
Walk to Train (Yes or No):			Yes
Walk to Door C (Yes or No):			Yes
When to Leave House			**6:36 AM**
Time Home to Bench	0:14	0:07	6:36 AM
Time Waiting for Train to Leave	0:03		6:50 AM
			6:53 AM
Minimum Train Departure Time			6:55 AM
Time Train Start to Stop	0:08		7:03 AM
Time Waiting for Shuttle to Leave	0:10	0:05	7:11 AM
Time Shuttle Drive to Terminal 1	0:11	0:09	7:16 AM
Time Terminal 1 to Door C	0:11	0:07	7:25 AM
Time Door C to Gate	0:13		7:32 AM
Time Bathroom & Stand By Gate	0:05		7:45 AM
Time Sitting on Plane	0:30		7:50 AM
			8:20 AM

Monte Carlo Simulation Output

(Note: This is not the actual data for the train)



Select a percent. Means 80% probability it will take <= 91.51 minutes.

Models are powerful for predicting/estimating the future.

Peer Reviews: Probably donʼt need the one on the left, but doing a Monte Carlo simulation on the right would be useful.

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- **Identify your goals before creating any baselines and models**
- **Analyze and disaggregate the data until it is stable (no special causes)**
- **Create multiple baselines when process variation (rush hour) is significant**
- **Understand each subprocess thoroughly to create better models. Analyzing subprocesses uncovers process variables (rush hour, car vs walking, shuttle vs walking, flight problems, etc.)**
- **Create models to estimate / predict the future**

Diane.Mizukami@ngc.com, 310-921-1939

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DEFINING THE FUTURE

Expanding Statistical Process Control Across All Engineering Disciplines

A Sequence of Practical Case Studies

November 15, 2007

Richard L. W. Welch, PhD
Northrop Grumman Corporation

ISER-MLB-PR-07-151

- **Purpose**
  - What you will see
- **SPC principles**
- **Prior presentations**
  - 2005 ï Log-cost model for controlling software code inspections
  - 2006 ï Statistical Process Control early in the system/software life cycle
- **Case studies from other disciplines**
  - Test
  - Avionics
  - Vehicle
  - Logistics
- **Summary**

- **Illustrate a variety of statistical process control (SPC) applications with realistic engineering case studies**
  - Multiple engineering disciplines
    - Software, hardware, logistics
  - Process improvements applied to selected processes when it makes sense for the business
- **Portray operations of a large organization that has been at Level 5 for 2$\frac{1}{2}$ years**
- **Suggest a potential range of SPC applications beyond software**

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Will See

- **Lots of control charts**
- **But that's not the point – you should focus on**
  - Broad applicability of SPC techniques to all engineering disciplines
  - Major business themes that emerge
    - Cost
    - Schedule
    - Quality
  - Vast majority of optimizing process improvements are simple in nature
    - But so is rocket science, *that's why it works*
- **Occasional out-of-control points**
  - All examples were taken from ñliveòproject data
    - Special causes of variation do occur, thatôs why we use SPC to manage projects

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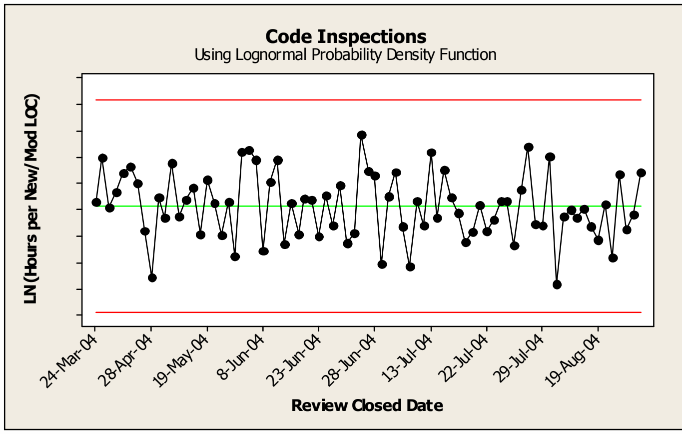
ples

Listening to the Voice of the Process



Upper Control Limit

Average performance

Lower Control Limit

A stable process operates within the control limits 99.7% of the time

Analysis of

- **Special cause variation** focuses on recognizing & preventing deviations from this pattern
  - Offers superior project management results
- **Common cause variation** focuses on improving the average and tightening the control limits
  - Offers opportunities for systematic process improvement that company & industry benchmarks indicate yields a return on investment averaging between 4:1 & 6:1

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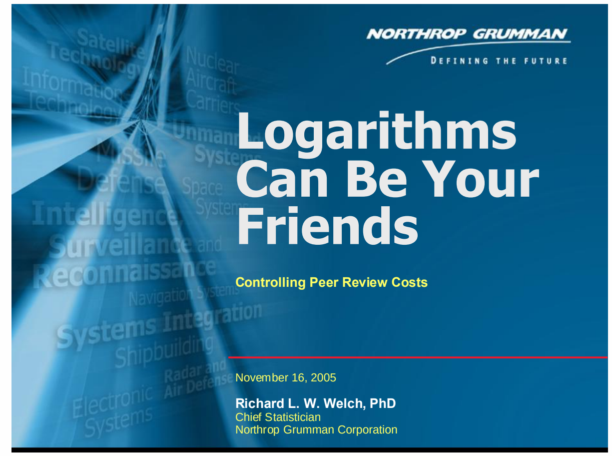
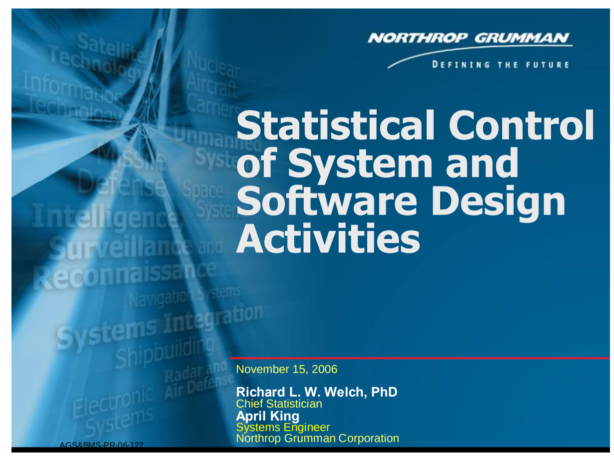
Process Selection

- **Statistical control is imposed on sub-processes at an elemental level in the process architecture**
- **Processes are selected based on their**
  - Statistical suitability ï ñnecessary conditionsò
  - Business significance ï ñsufficient conditionsò
- **Business checklist**
  - Is the candidate sub-process a component of a projectõs defined ñkeyòprocess?
    - Is it significant to success of a business plan goal?
    - Is it a significant contributor to an important estimating metric in the discipline?
  - Is there an identified business need for predictable performance as projects execute the subprocess?
    - Cost, schedule or quality
  - Is there risk if subprocess variation is not understood or controlled?

ntations

- **2005 – Author demonstrated applicability of a log-cost model to control software code inspections**
- **2006 – Author demonstrated how to use the log-cost model to control peer reviews early in the system/software life cycle**
  - ñOutstanding Presentation for High Maturityò
  - ñConference Winnerò





Note: Prior CMMI Technology Conference & User Group papers are published on-line at: http://www.dtic.mil/ndia/

Statistically Managed Processes

Covered in the Prior Presentations

- **System Engineering**
  - System design & system architecture peer reviews of
    - System threads
    - System model (structure diagrams)
    - Physical model
    - UML diagrams
  - System & software requirements peer reviews of
    - Proposed specification changes
- **Software Engineering**
  - Software design peer reviews of
    - Software threads
    - Physical model
    - Component/task descriptions
    - Data model
  - Software code inspections
- **Test & Engineering**
  - Peer reviews of test plans, procedures & reports

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...y Managed Processes

Other Engineering Baselines

- **System Engineering**
  - System product errors
- **Software Engineering**
  - Software build process
  - Software build returns
  - Software test returns
- **Test & Engineering**
  - *System Integration Lab (SIL) scheduling*
  - *Flight Test Card development*
- **Vehicle Engineering**
  - Electro-mechanical drawing errors
  - *Vehicle subsystems (i.e., crew & equipment) drawing errors*
- **Avionics**
  - *Discrepancy Inspection Report (DIR) processing*
  - Avionics Drawing Sign-off
  - *Field Service Engineering Request (FSER) processing*
  - Management of seller issues
- **Logistics**
  - *Air Force Tech Order (AFTO) processing of the*
    - *Total contractor schedule*
    - LSA group schedule
  - *Integrated electronic technical manual (IETM) delivered quality*

Baselines span all life cycle phases & disciplines

Note: baselines highlighted in italics are featured in this presentation.

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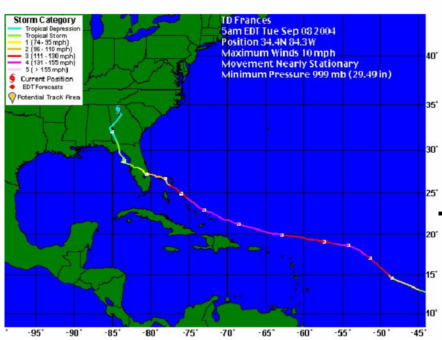
DEFINING THE FUTURE

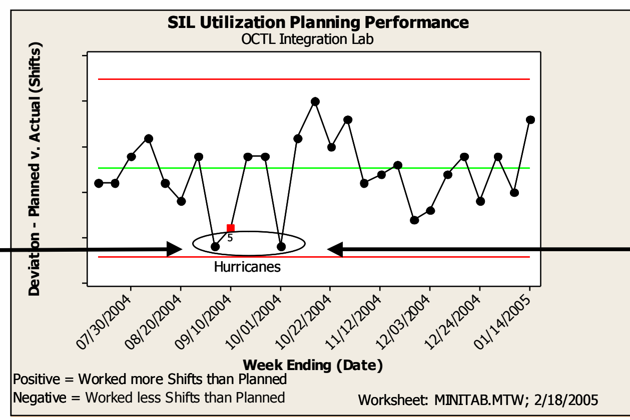
Test & Evaluation

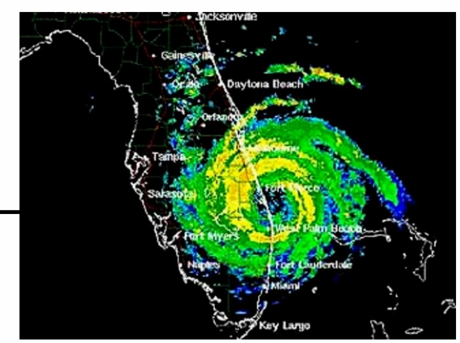
System Integration Lab Scheduling
Flight Test Card Preparation

luation

- **An early 2005 analysis determined that improved System Integration Lab (SIL) resource utilization could provide significant cost savings**
  - Scheduled shifts not worked waste Lab Ops resources
  - Unplanned, late requests for lab support induce overtime expenses
- **Statistical analysis of past year's data revealed the process was stable (with two unusual exceptions)**







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tion Scheduling

Process Overview

Process Title Lab Utilization Scheduling

Process Definition Provides deconflicted and effective Lab utilization by various projects.

Input

Varied Integrated Product Team (IPT) Requirements

Sub-Processes Steps

ÅIPT Rep Identifies Requirements
ÅNext Months Baseline Established
ÅWeekly Schedules Developed & Posted
ÅWeekly Schedules Marked to Reflect Actuals
ÅPlanned (Monthly Baseline) Versus Actual Metric Created

Output

ÅLong Range Schedule
ÅNext Month Baseline
ÅWeekly Schedules
ÅPlanned Versus Actual Metric

Applicable Procedures

ÅLong Range Lab Utilization Scheduling
ÅWeekly Lab Scheduling

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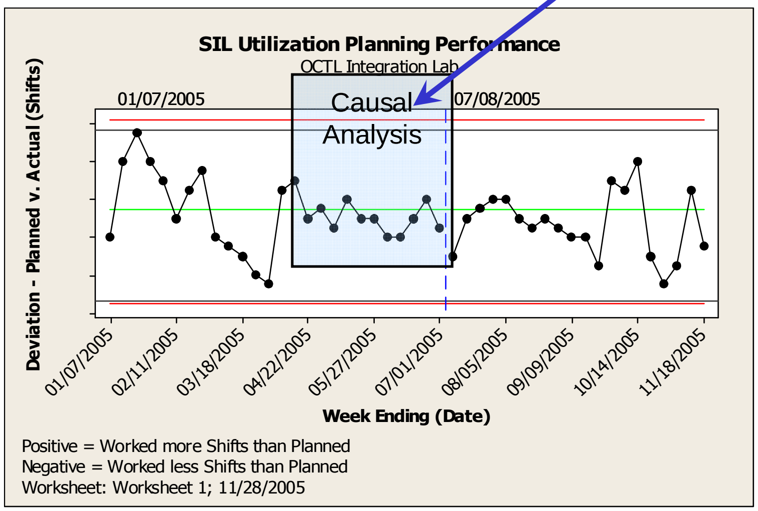
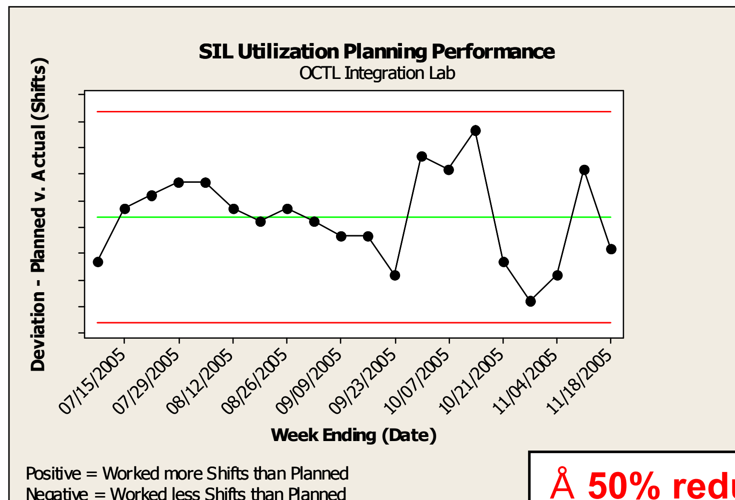
ent Focus

- **Training**
  - Re-affirmed the need for accurate planning
  - Revised lab planning procedures disseminated widely
- **Tools**
  - Planned vs. Actual utilization spreadsheet ï tracks the lab utilization deviations
- **Process**
  - Steering Committee approval of remedial actions
  - Integrated Product Teams notified monthly about their laboratory utilization performance

g to an Improved Process

Remedial Actions Implemented 07/08/2005





- 50% reduction in unplanned shifts
- 18% reduction in variability

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Cards

- **Flight Test Card Deck Preparation**
  - Time consuming process
  - Incomplete data provided from test plan
  - Too much pulling of info required to build deck
  - Last minute changes disrupt process
  - Development efforts force last minute input
  - Process not well defined or documented
  - Customer perception of *incomplete planning efforts*
  - Customer request for *more time to review* flight cards

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Card Development

Process Title	Flight Test Card Development

Process Definition

Gather flight test requirements, write the Test Point (Test Card) steps, plan and write the mission profile, assemble the deck and receive review approval

Input
- VCRM
- Integrated Test Plan
- Flight (Detailed) Test Plan
- Test Cards *

Sub-Processes Steps
ÅObtain objectives and requirements
ÅDevelop test card from approved inputs
ÅPrepare for and conduct reviews
ÅCirculate Flight Deck for signature
ÅConduct Technical Brief and distribute test cards

Output
ÅAccurate flight deck (mission profile and test cards)
ÅSufficient Joint Test Force (JTF) review of flight deck prior to flight

Applicable Procedures
ÅTechnical Mission Support ï Flight Card Preparation

Applicable Tools
- Microsoft Word, Archived Test Cards, reviews and meetings

* Test cards are not always provided by the project and are written by the test conductor

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...ent Focus

- **Completed brainstorming session for process improvements**
  - Immediate implementation of priority items
- **Process highlights**
  - Documented process with roles and responsibilities
  - Defined input requirements
  - Required test card review prior to submitting deck for approval
- **Early deployment of new Sector test card development procedure**
  - Start date advanced from October to June

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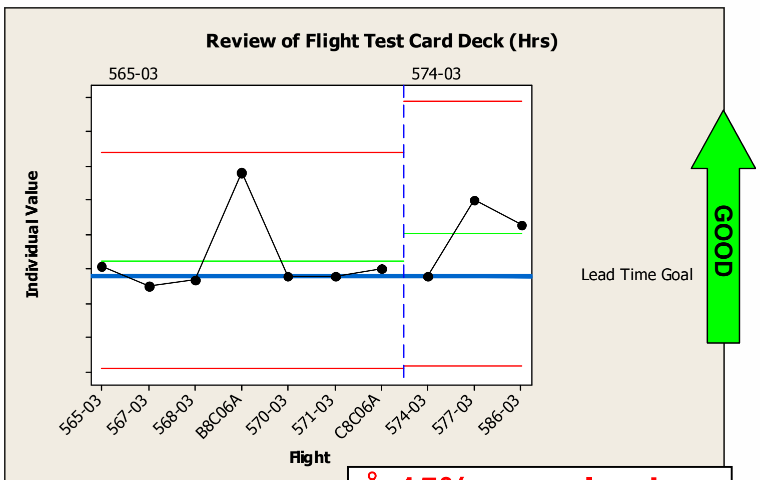
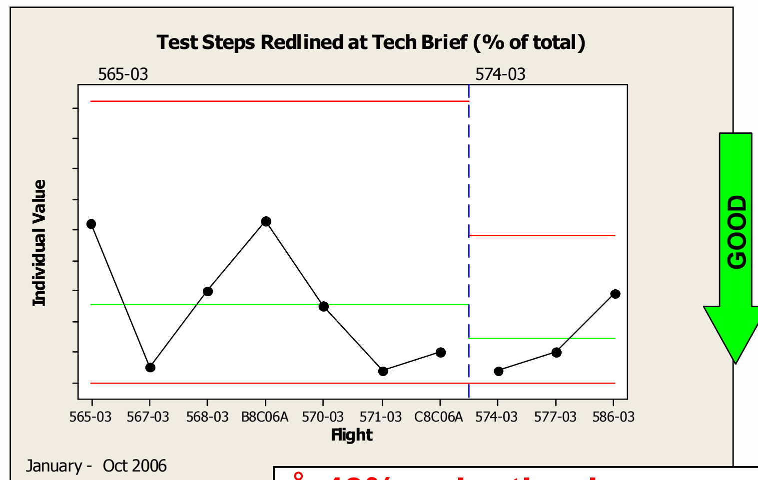
…g to an Improved Process

- **Lead Time for Customer Review**
- **Reduce Redlines at Tech Brief**



Å 15% more lead time for the review



Å 43% reduction in errors
Å 47% reduction in variability

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DEFINING THE FUTURE

Vehicle Engineering

Drawing Errors

gineering

- **Generation, review & release of engineering drawings is the fundamental business process in Vehicle Engineering**
- **The release process is key to ensuring drawing quality & minimizing future rework**
  - Like peer reviews in the system/software world
- **2006-2007 initiative featured improvements to the release of Direct Drawing Changes**
  - Follow-on to 2005 initiative to improve the release of new drawings
  - Initiatives cover electro-mechanical & vehicle subsystem drawings

elease

- **New Drawings (ND)**

Process Title: Review and Release

Process Definition: This process focuses on the review and release of New Drawings (ND) in Vehicle Engineering

Input
- Drawing Release Requirements

Sub-Processes Steps
- Review ND
- Release ND

Output
- Approved ND
- Checklists
- Configuration Control

Applicable Procedure
- NGC Procedures, Contractual documents

Applicable Tool
- **Design** - CATIA, HarnesSys, CADAM, EIDS
- **PKM** - IEDB, Metaphase, TcE

- **Direct Drawing Changes (DDC)**

Process Title: Review and Release

Process Definition: This process focuses on the review and release of Direct Drawing changes (DDC's) in Vehicle Engineering.

Input
- Completed DDC's

Sub-Processes Steps
- Review DDC
- Release DDC

Output
- Approved DDC
- Checklists
- Configuration Control

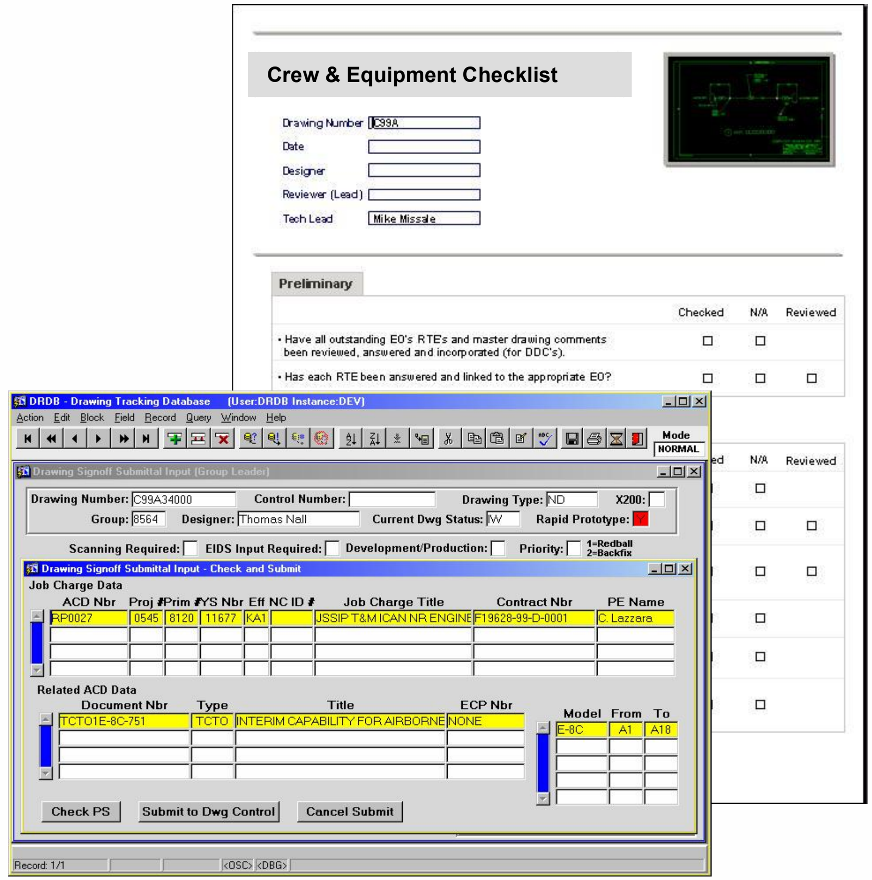
Applicable Procedure
- NGC Procedures, Contractual documents

Applicable Tools
- **Design** - CATIA, HarnesSys, CADAM, EIDS
- **PKM** - IEDB, Metaphase, TcE

Note: A similar process is used for release of Engineering Orders (EOs). Due to the wider variability among EO types/groups, EO baselines are still under development.

nprovement Focus

- **Created and Utilized DDC Checklists**
- **Leveraged improved engineering database for new DDC data collection**



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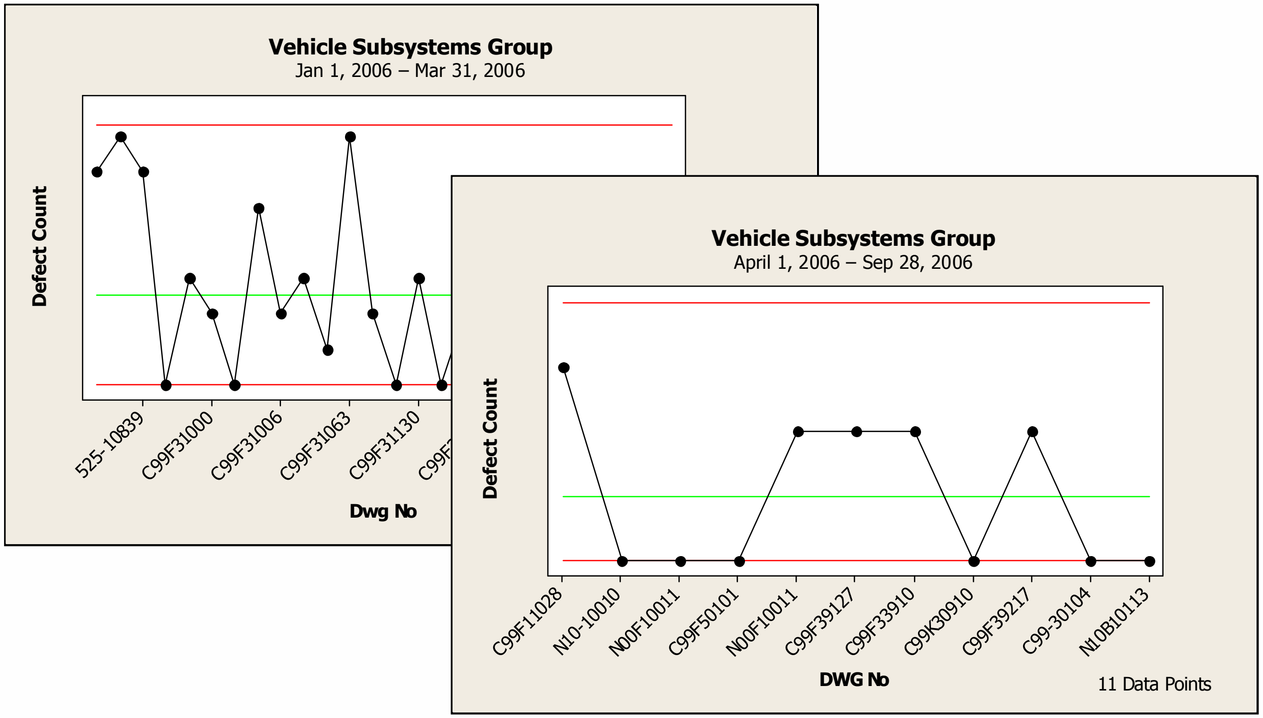
g to an Improved Process



Å 61% reduction in drawing errors
Å 45% reduction in variability

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DEFINING THE FUTURE

Avionics

Discrepancy Inspection Report Processing
Field Service Engineering Request Response

- **In 2005 & 2006, there was a general attempt to baseline and control significant Avionics processes to leverage the benefit of the site's SPC capabilities**
- **Candidates selected based on Pareto analysis**
  - Processing of discrepancy inspection reports (DIRs) for nonconforming items
  - Review of engineering drawings
  - Response to field service engineering requests (FSERs) from field service reps
  - Response to seller issues
- **Process improvement opportunities noted & implemented for DIR processing and FSER response**

First 3 baselines utilize extensions of the author's log-cost model

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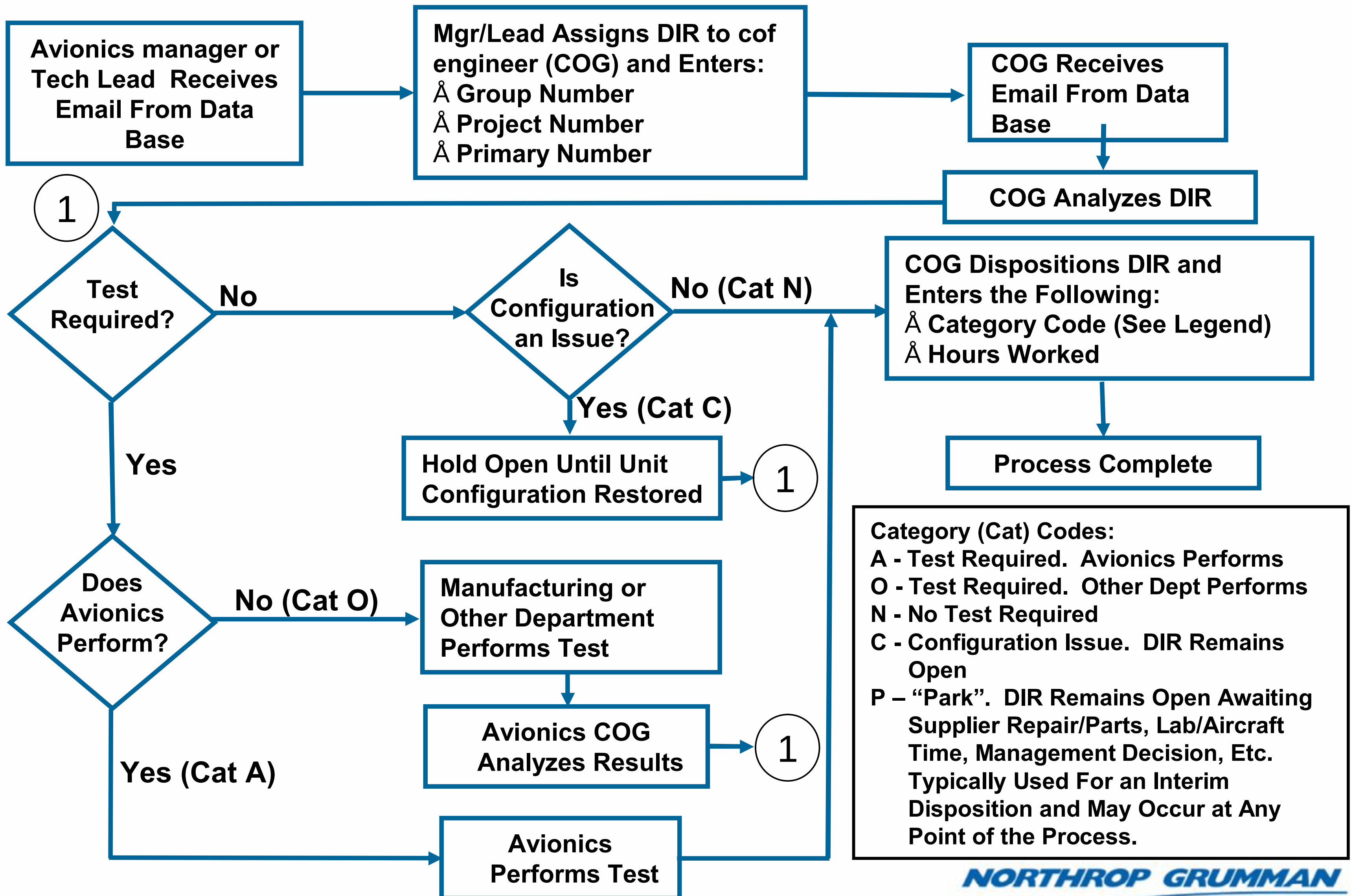
…cy Inspection Report (DIR) Process



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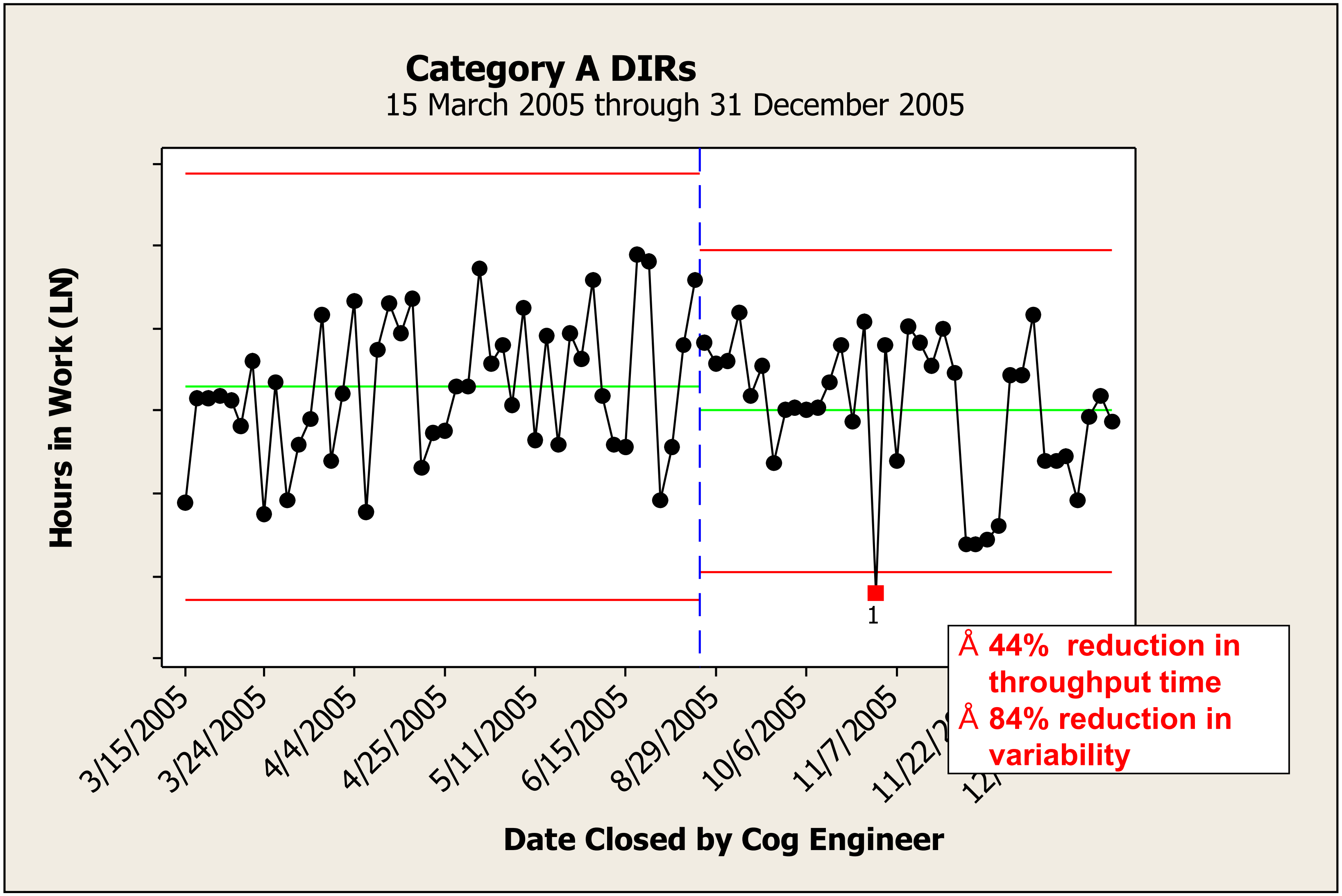
ent Focus

- **Revised existing Avionics work instruction**
- **Optimized Manager/Tech Lead DIR notification and assignment; instituted assignment cross-check to ensure same day assignment**
- **Implemented weekly status reporting & review by Avionics management**
  - Automated management follow-up for DIRs open for 5 days
  - Implemented Category ñPòfor DIRs in work by other groups (Vendor, Lab Ops, etc.)
- **Conducted training**

g to an Improved Process



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onse

Process Title	Field Service Engineering Request Disposition
Process Owner	Avionics Engineering ï Director
Process Definition	Process Field Service Engineering Requests (FSERs) routed to Avionics Engineering for review, analysis and disposition.

Supplier	Input	Sub-Processes Steps	Output	Customer
FSER Review Board	FSER Review Board Request	▪ Determine Actionee group within Avionics ▪ Selects Avionics Engineer as an Actionee ▪ Notifies FSER Review Board of Avionics Actionee(s) ▪ The FSER enters ñLevel 5òof FSER tool. ▪ Conduct kickoff meeting for new FSERs ▪ Dispositions FSER. ▪ Update status Weekly ▪ Generate final response in the FSER Tool ▪ Review final response	▪ Dispositioned (Approved or Disapproved) Field Service Engineering Request	FSER Review Board

Documents/Tools	Field Service Engineering Request Tool; Field Service Engineer Request
Metrics	FSER Disposition Touch Time; FSER Count; Approval and Disapproval Rates; FSER Review Board (Customer) Feedback
Expected Results	FSER that are completely and accurately disposition. Comments that are appropriate, clear, succinct, technically accurate and which meet customer expectations.

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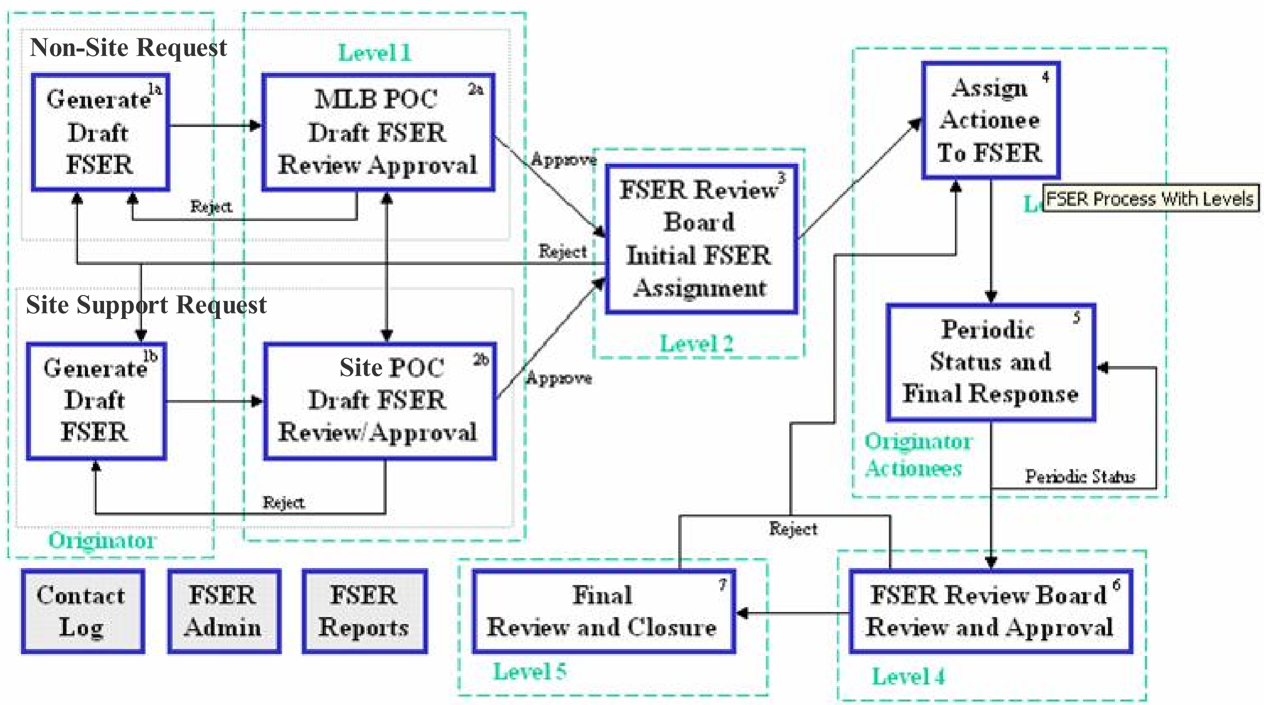
...provement Focus

- **Issued new Avionics work instruction with automated work assignment, tracking & management follow-up**

The following navigation chart represents the different steps in the FSER process. To work with FSER data, select the box corresponding to the desired action. If you do not have permissions for a particular step, that step will not be a hot link.



View Process Flow Without Levels

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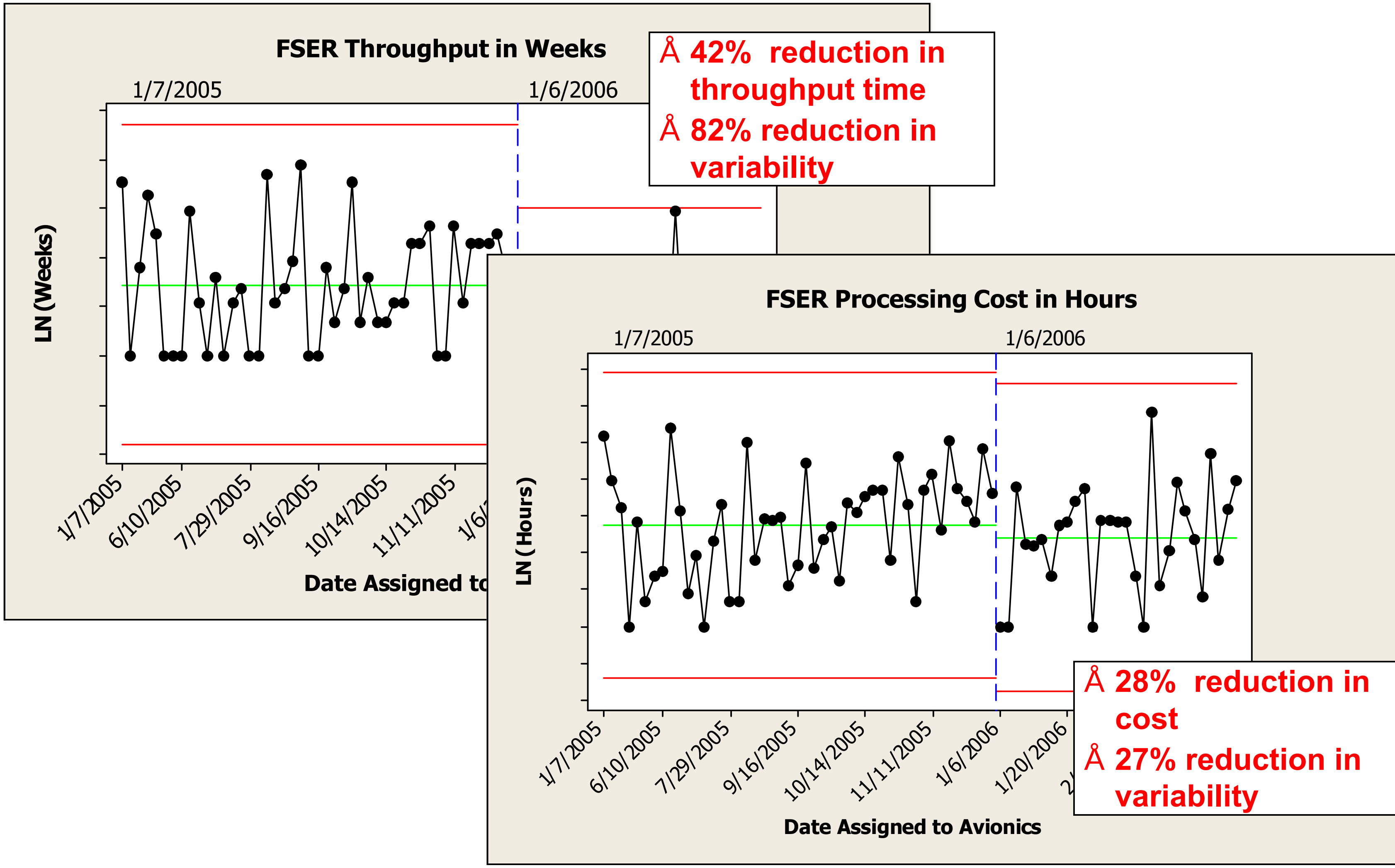
…g to an Improved Process



Å 42% reduction in throughput time
Å 82% reduction in variability

Å 28% reduction in cost
Å 27% reduction in variability

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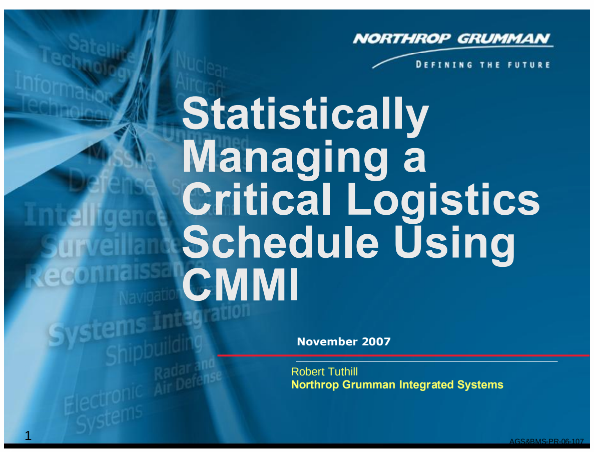
DEFINING THE FUTURE

Logistics

Air Force Tech Order Processing Schedule
Integrated Electronic Technical Manual Delivered Quality

- **In 2004, the Customer requirement to incorporate routine Air Force Technical Orders (AFTO Type 22) into the Joint Integrated Maintenance Information System (JIMIS) was a relaxed schedule**
- **In 2005, Northrop Grumman transitioned to a Total System Support Responsibility (TSSR) sustainment contract**
  - On-time delivery became a component of the TSSR award fee
  - The AFTO 22 delivery requirement was reduced by 57% with the new spec limit



Case study details

AFTO 22 Incorporation

Process Overview

Process Title AFTO Disposition and Incorporation Process

Process Definition Air Force Technical Order (AFTO) Form 22 is the method by which the government recommends changes/ improvements to Technical Manuals. Northrop Grumman dispositions and incorporates the AFTOs issued by the government into Manuals.

Input
- AFTO 22 submitted by JTF
- AFTO 22 Submitted by 116th Wing

Sub-Processes Steps
- NG at Warner Robins dispositions AFTO
- LKS Review & Approval of AFTO
- Processing Days in LKS
- Develop Data Changes in LSA Melbourne
- Incorporate AFTO into JIMIS
- Review Time in Pubs Tech Support
- Gov't Review in Live Feed
- Release of Data
- Data Fielded for use

Output
Tech Orders fielded for usage by the 116th wing

Applicable Procedures
- AFTO Disposition and Incorporation Procedure

Applicable Tools
JIMIS Database, AFTO Database (Access) , Management tracking tool (Excel)

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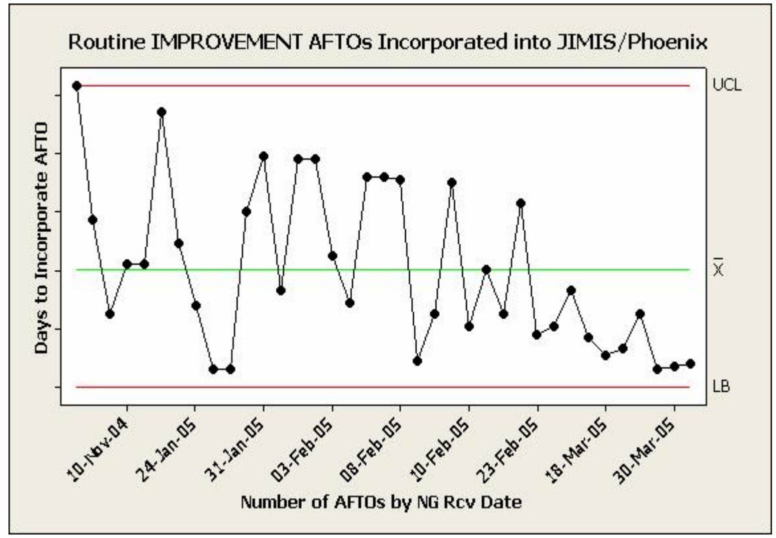
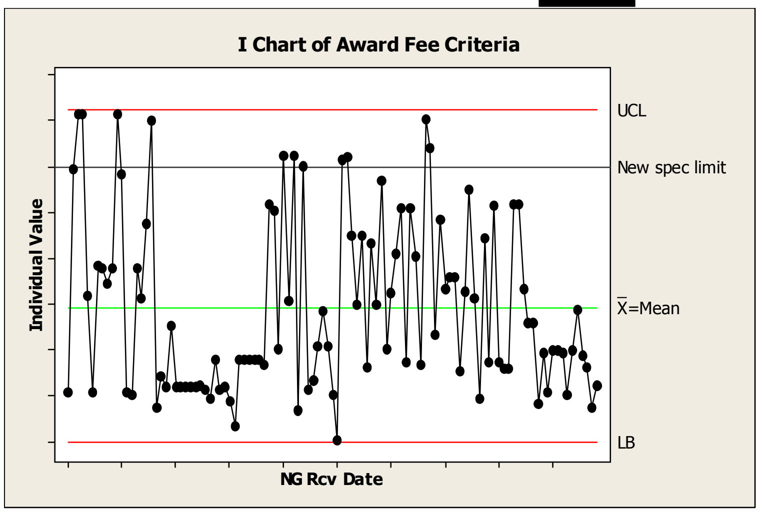
Process Improvement Focus

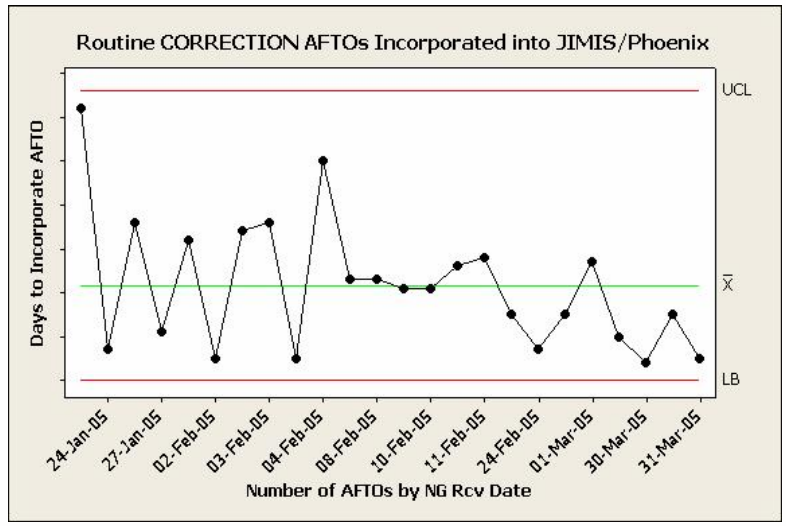
- **In 2004, analysis was conducted on that year's entire data set**
  - Of all data points at or above the new spec limit:
    - 67% resulted from Improvement AFTOs
    - 33% resulted from Correction AFTOs
- **Although not conclusive, preliminary analysis suggested that the two subgroups might have different distributions**
  - This would indicate they should be charted separately
- **Process improvements focused on improving the assignment & management of open AFTO items**

Two Baselines in 2005:
ent & Correction AFTOs

Å 32% reduction in throughput time
Å 29% reduction in variability







Å 62% reduction in throughput time
Å 54% reduction in variability

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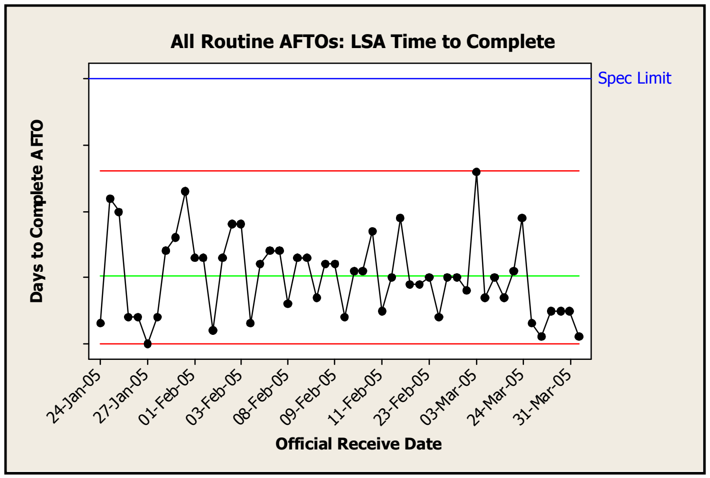
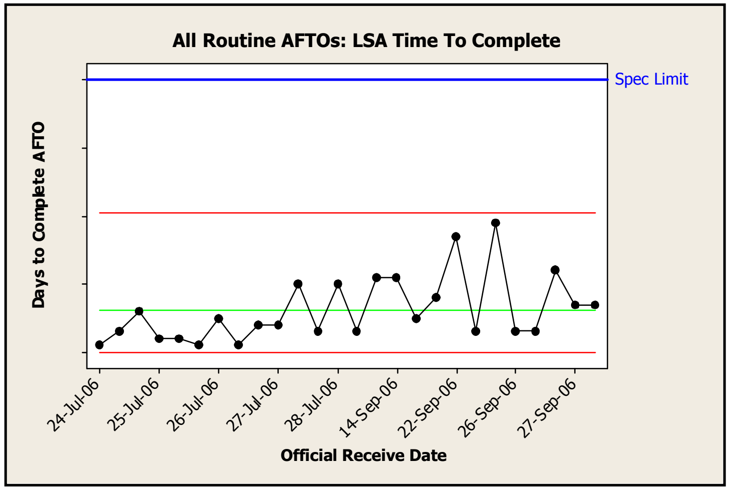
- 2006 process improvement focused on control & optimization of the Logistics Support Analysis (LSA) sub-process within the AFTO 22 process
- Similar steps resulted in
  - 40% reduction in the LSA throughput time
  - 24% reduction in the process variability





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t JIMIS

- **JIMIS is a complex, interactive relational database**
  - Integrated electronic technical manual (IETM)
- **Database Size ~ 7.5 GB**
  - > 100,000 pgs of text
  - Replaces ~ 400 technical manuals
- **Used to maintain Joint STARS aircraft**
  - 116th Wing at Warner Robins
- **JIMIS data development – DCMA rated high risk process**
  - Manned aircraft
  - Database changes affect multiple aircraft
  - Errors in maintaining data can have serious consequences on weapon system performance
- **Government reviews new/changed data for quality**
  - ~ 400 submitted in each release cycle (every 75 days)
- **Contract imposes quality performance targets**

NORTHROP GRUMMAN

provement Focus

- **Improved review process**
  - Expanded scope of review
  - Increased standardization of review methods
  - Instituted face-to-face review feedback meetings
  - Synchronized timing of Government review with completion of internal review
- **Better match of reviewers expertise to components reviewed**
- **Automated tracking of review status**

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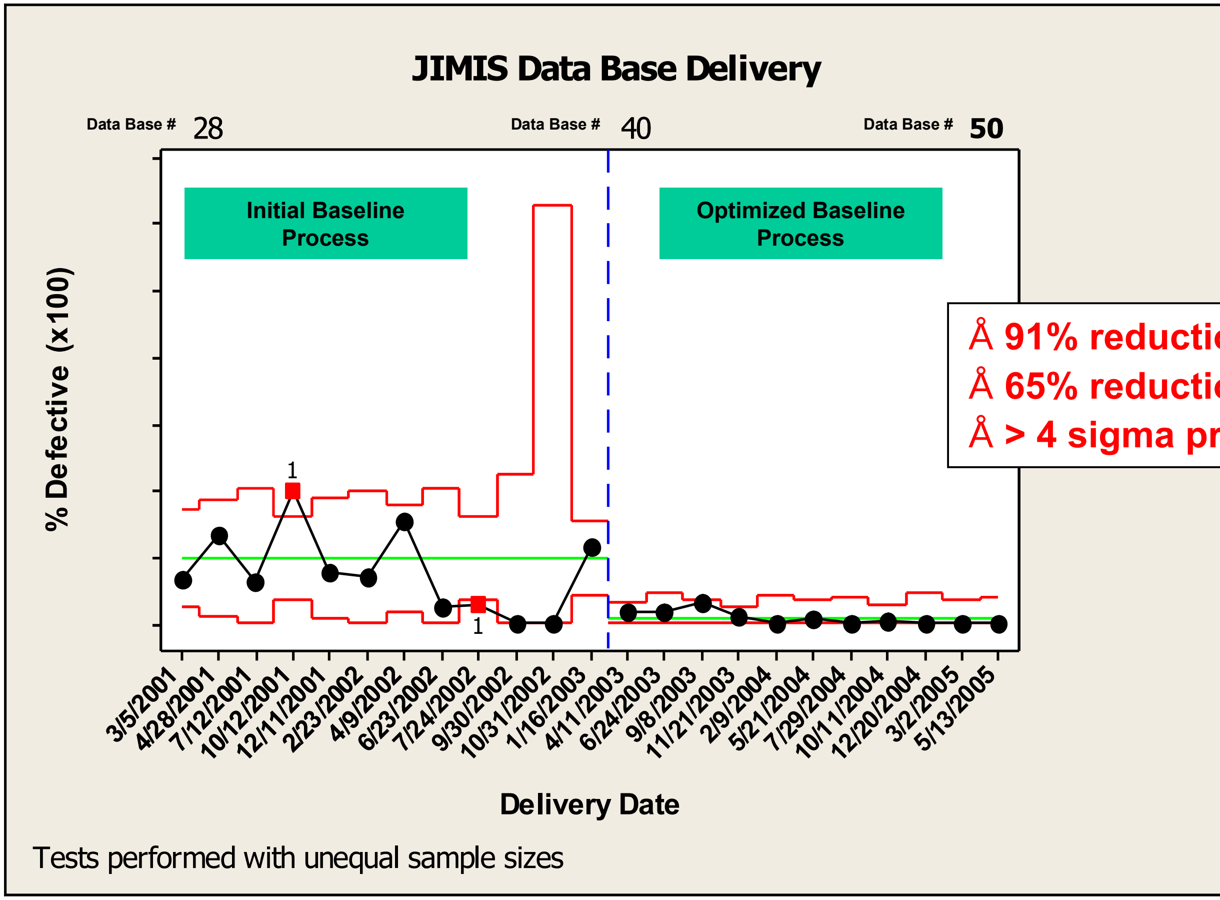
to an Improved Process



- Å 91% reduction in errors
- Å 65% reduction in variability
- Å > 4 sigma process capability

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- **SPC techniques are broadly applicable in any engineering disciplines**
- **Controlling & improving key business metrics yield measurable benefits**
  - Cost
  - Schedule
  - Quality
- **Simple process improvements work in the real world**
  - Standardization
  - Oversight
  - Automation
  - Training

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Raytheon
Customer Success Is Our Mission

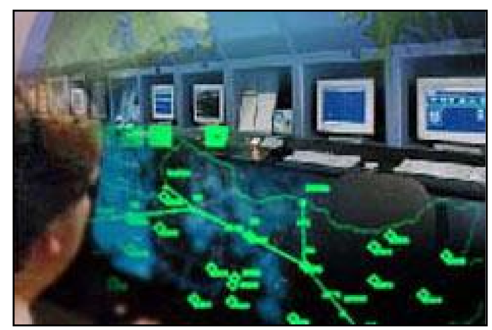
5 Major Sites,
4 Separate Disciplines,
5,221 Engineers,
1 Data Repository:
Having data you can actually use – Priceless!

Raytheon

- Introduction to Raytheon
- Measurement-related Goals
- Measurement Process Overview
- Best Practices
  - Measurement Definition
  - Measurement Collection
  - Measurement Analysis
  - Tooling/Automation
- Future Opportunities
- Results
- Q & A

Raytheon and NCS

- Raytheon is an industry leader in defense and government electronics, space, information technology, and technical services
- Network Centric Systems (NCS) develops and produces mission solutions for networking, command and control, battle space awareness, homeland security and air traffic management



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tes and Overall Goal

Å NCS Engineering Organization = Over 5,000 individuals

Å Number of programs to appraise = 33 (CA 8, TX 4, IN 9 , FL 4, MA 8)

Å Various levels of CMMI maturity at the project onset

...nprovement Journey: ...Related Goals

Raytheon

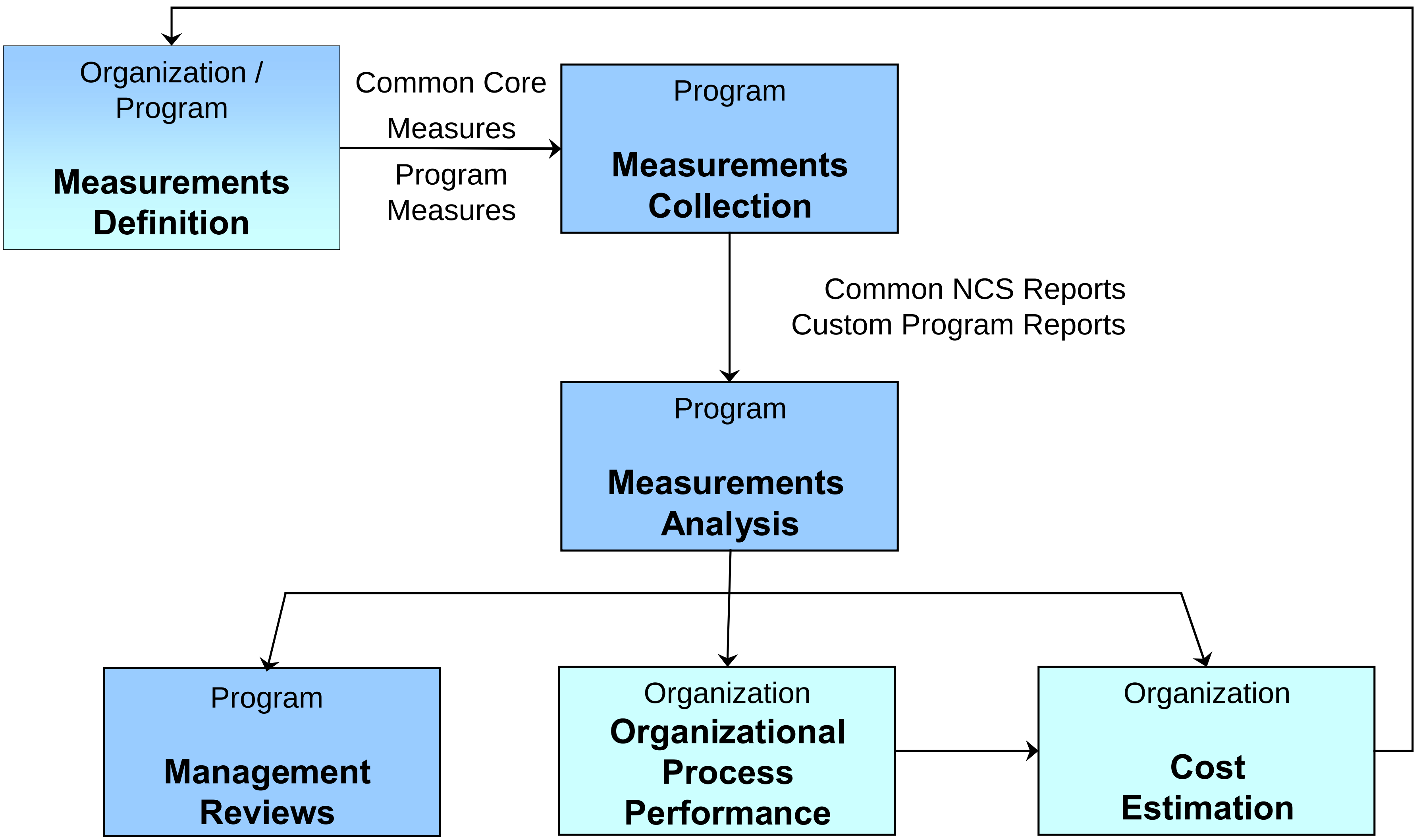
- Establishing a Common Measurement Program
  - ï All major NCS sites and engineering disciplines
  - ï Common plans and work instructions that support CMMI Level 5
  - ï Common process and tooling

- Consistent Approach
  - ï Define core set of engineering measures
  - ï Define analysis that should occur at various levels
  - ï Define measures roll-up as related to NCS goals
  - ï Define a set of CMMI Level 4 Sub-process approaches

- Have a ñone companyò look to our customers
  - ï Accurate historical data and consistent estimates across sites
  - ï Support Mission System Integrator (MSI) role
  - ï Support multi-site bids and work transfers between sites

Raytheon

rocess Overview

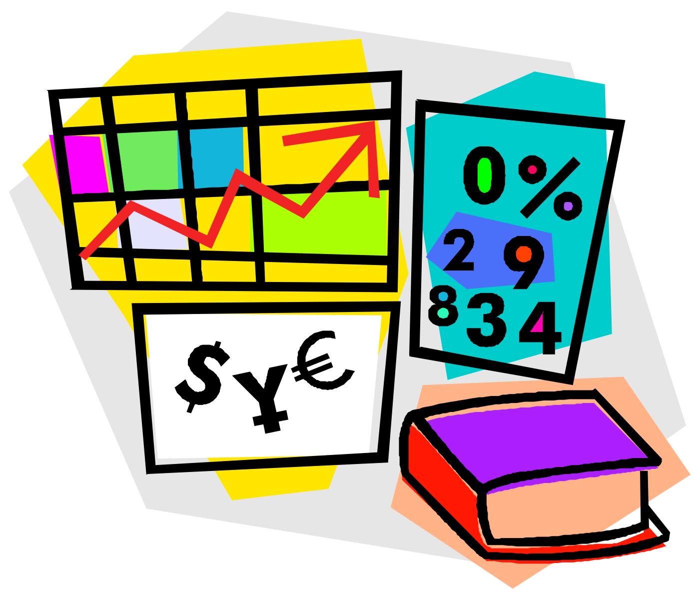


Definition:
ng Measures

Raytheon

- Cost and Schedule Measures
- Defect Containment
- Staffing Profile
- Measurement Compliance
- Change Management
- Peer Review
- Requirements Volatility
- Design Margin Index (DMI)
- Size
- Productivity

There were many more measures, but Engineering started with a list of core measures



Definition: Cost Collection Scheme

Raytheon

ACTIVITY TITLE	PE	SE	SW	HW: General Hardware	HW: Analog	HW: Digital	HW: FPGA	HW: Mechanical
PROJECT PLANNING & MANAGEMENT								
Planning and Management								
Quality Engineering								
Configuration Management								
REQUIREMENTS DEVELOPMENT								
System Requirements Definition								
System Design & Architecture								
Product Requirements Definition								
Product Design & Architecture								
Component Requirements Definition								
PRODUCT DESIGN & DEVELOPMENT								
Requirements Management								
Simulation and Modeling								
Preliminary Design								
Detailed Design								
Implementation								
Integration								
SYSTEM INTEGRATION & VALIDATION								
Product Verification & Validation								
System Integration								
System Acceptance Test								
System Field Test								

- Aligns disciplines and activities
- Used to identify and collect costs for Work Breakdown Structure (WBS) elements
- Scheme is aligned with Cost Estimation
- Facilitates collection of consistent historical data
- Defect data can be collected in these bins

Sets the foundation for CMMI Level 5 by aligning cost, schedule, and quality data

Definition:
res have Consistent Elements

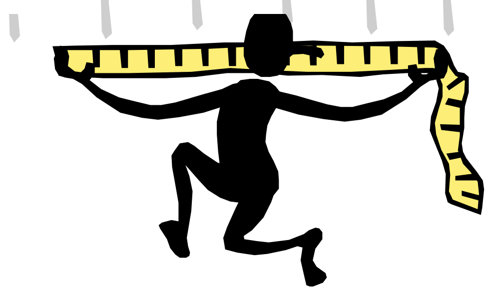
- Size measures were defined for Systems Engineering (SE), Software (SW), Hardware (HW)-Electrical, HW-FPGA (Field-Programmable Gate Array), and HW-Mechanical disciplines
- Sizes for each discipline were defined to have the capability to be converted to equivalent size units, where equivalent means equivalent to requiring the same amount of effort as developing it from scratch
- Each discipline's size data includes these elements
  - **Reused**
  - **Modified**
  - **New**
  - **Reuse Factor (F_R)**
  - **Modified Factor (F_M)**

Equivalent = New + (Modified * F_M) + (Reused * F_R)

Definition: Measures with COSYSMO

Raytheon

- Raytheon created the SECOST tool, which aids deployment and company calibration with the Constructive Systems Engineering Cost Model (COSYSMO)
- NCS System Engineering sizes are aligned with COSYSMO sizes
- For each system of interest these are collected to compute equivalent requirements (EREQ):
  - System requirements
  - System interfaces
  - System algorithms
  - System scenarios
- For a complete SE size set of requirements data, additional NCS SE size measures include:
  - Software product requirements
  - Hardware product requirements
  - Hardware component requirements



Definition:
ductivity Activities

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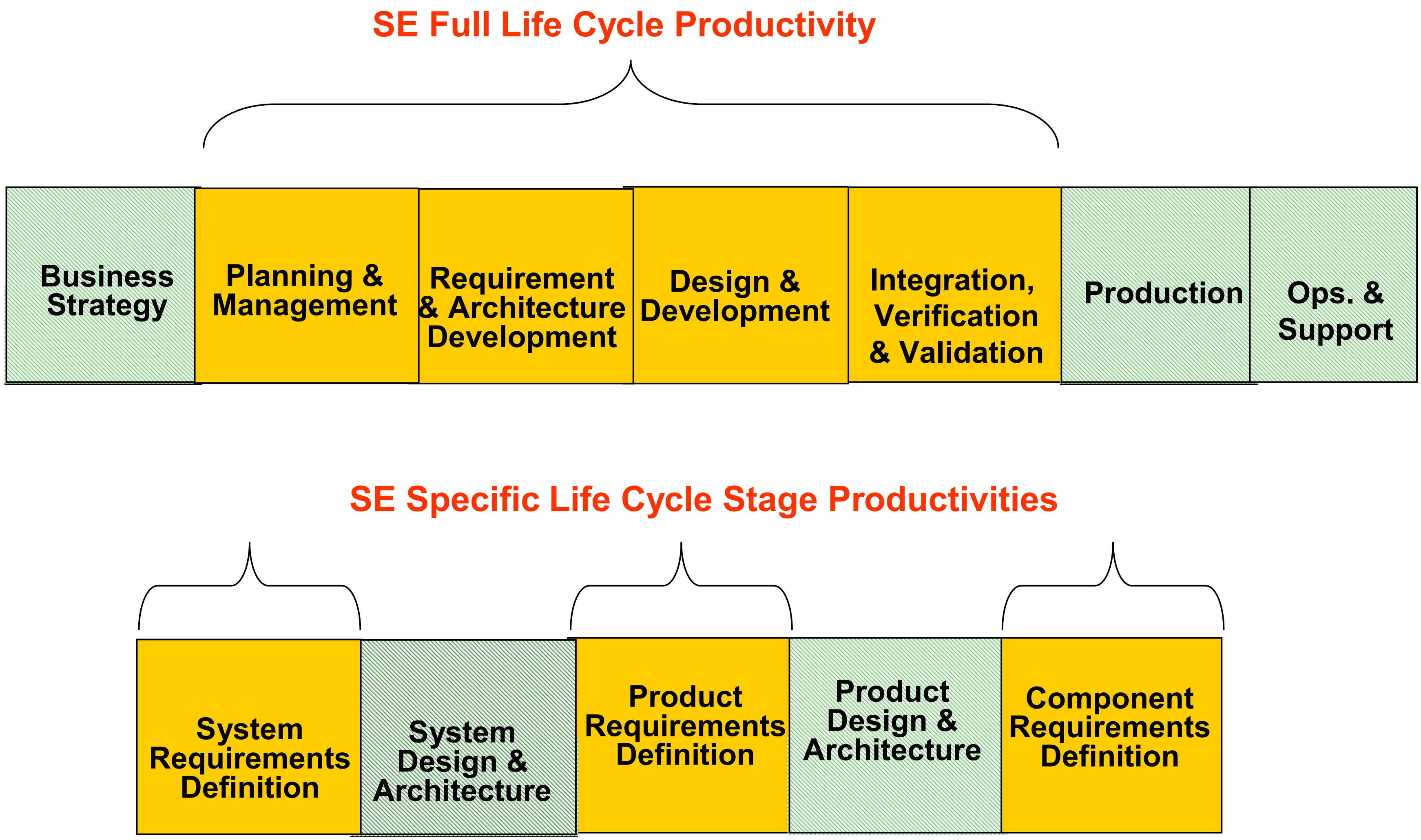
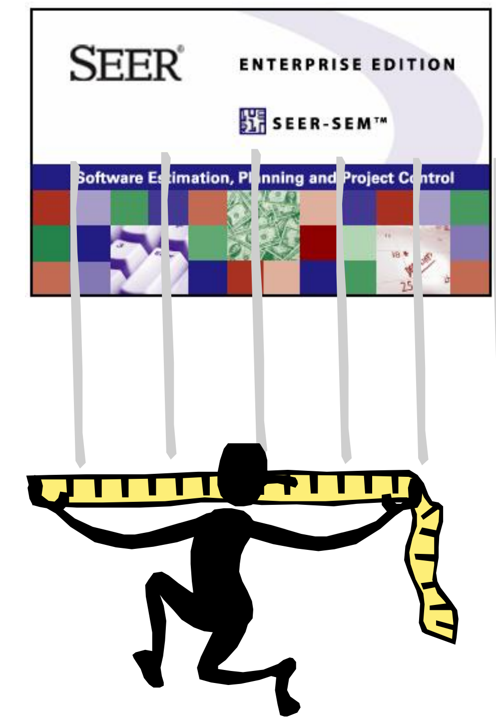


Specific cost collection codes are used to capture hours for Productivity measures

Definition:
Measures with Cost Models

- Raytheon has used parametric SW models such as COCOMO, COCOMO II, REVIC, Price-S, and SEER-SEM for many years
- Specific alignment was made to the SEER-SEM SW Application types to allow stratification of data such as productivity
- NCS SW Size measures support these models with parameters of Source Lines of Code (SLOC) categorized by Reused, Modified, and New, with Reuse and Modified Factors
- A standard NCS software line counting tool was deployed across all sites so that sizes are measured consistently and with automation



Definition: ductivity Activities

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SW Development Productivity Stages

Rqmts & Arch. Devel.	Prelim. Design	Detailed Design	Implement-ation	Integration	Verification & Validation	Production	Ops. & Support

Specific cost collection codes are used to capture hours for Productivity measures

Definition:
ures

Raytheon

HW Sub-Discipline	Size Unit	Definition of Size Unit
Electrical	Terminations	Termination count is the sum of all external physical leads
FPGA	FPGA Lines of Code	Lines of Code - like software engineering
Mechanical	Square Feet of Drawing	The square feet of drawings required to document the design

Hardware Size Units are an indication of which hardware sub-discipline is producing this data

Definition:
ductivity Activities

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HW Development Productivity Stages

Reqs & Architecture Devel.	Prelim. Design	Detailed Design	Implement-ation	Integration	Verification & Validation	Production	Ops. & Support

Collected separately for:

ÅElectrical

ÅFPGA, and

ÅMechanical

Quantitative Analysis: Program Activities

MTBF ï Mean Time Between Failures
AUPC ï Average Unit Production Cost
DPMO ï Defective Parts per Million Opportunities

CPI

SPI

Defect Containment

Productivity

Standard Process, Tools, Enablers, Technology

Inspection Calculator:
Peer Review Defect Density
Review / Development Stage

Price-H:
AUPC
Design for Cost

ASENT/Block SIM:
MTBF
Requirements Analysis/
Design for Reliability

Legend
ÅTool
ÅMeasure
ÅSub-process

PCAT:
Cost, DPMO
Design for Cost /
Design for Producibility

SECOST:
Effort hours by stage
Development Stage

Programs have a variety of tools and models to use for statistical control

- Analysis: Baselines - Peer Review Example

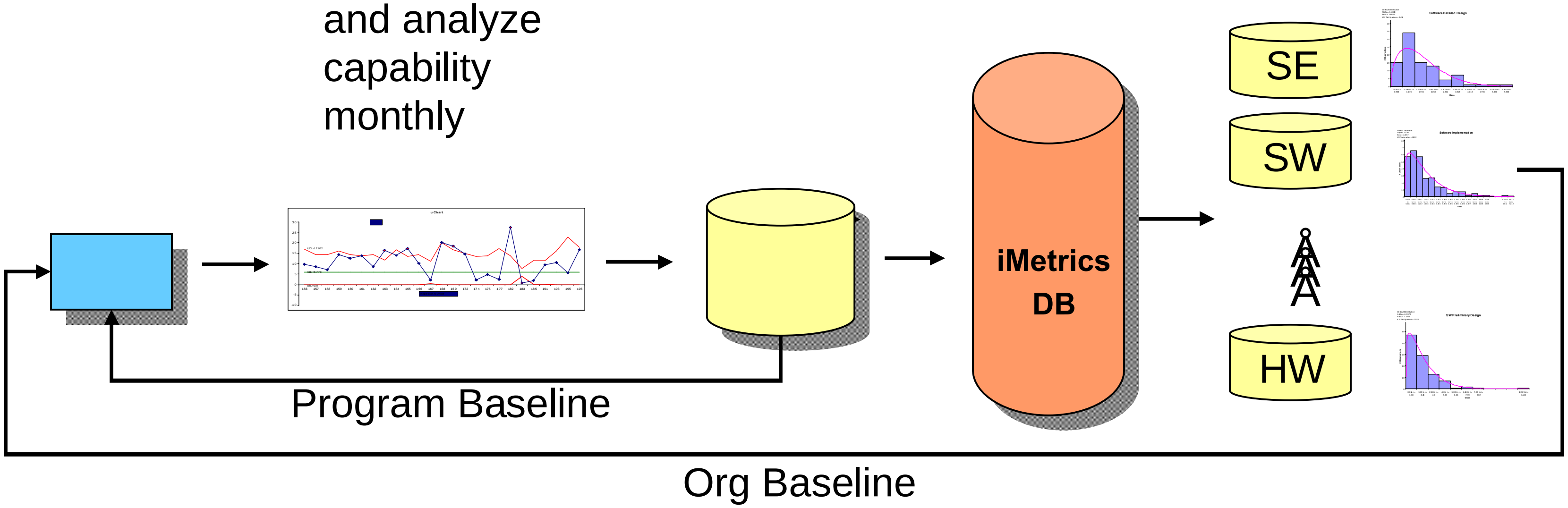
Program Execute Peer Reviews

Programs select baselines, use control charts, and analyze capability monthly

Programs record Peer Review data in review tools

Measurement Repository

Establish Org Baselines



- Programs use latest org baselines and program/product line baselines
- Baselines are recalculated periodically and then fed back to programs
- Peer review tools are updated to include new org norms

Analysis: to Architecture

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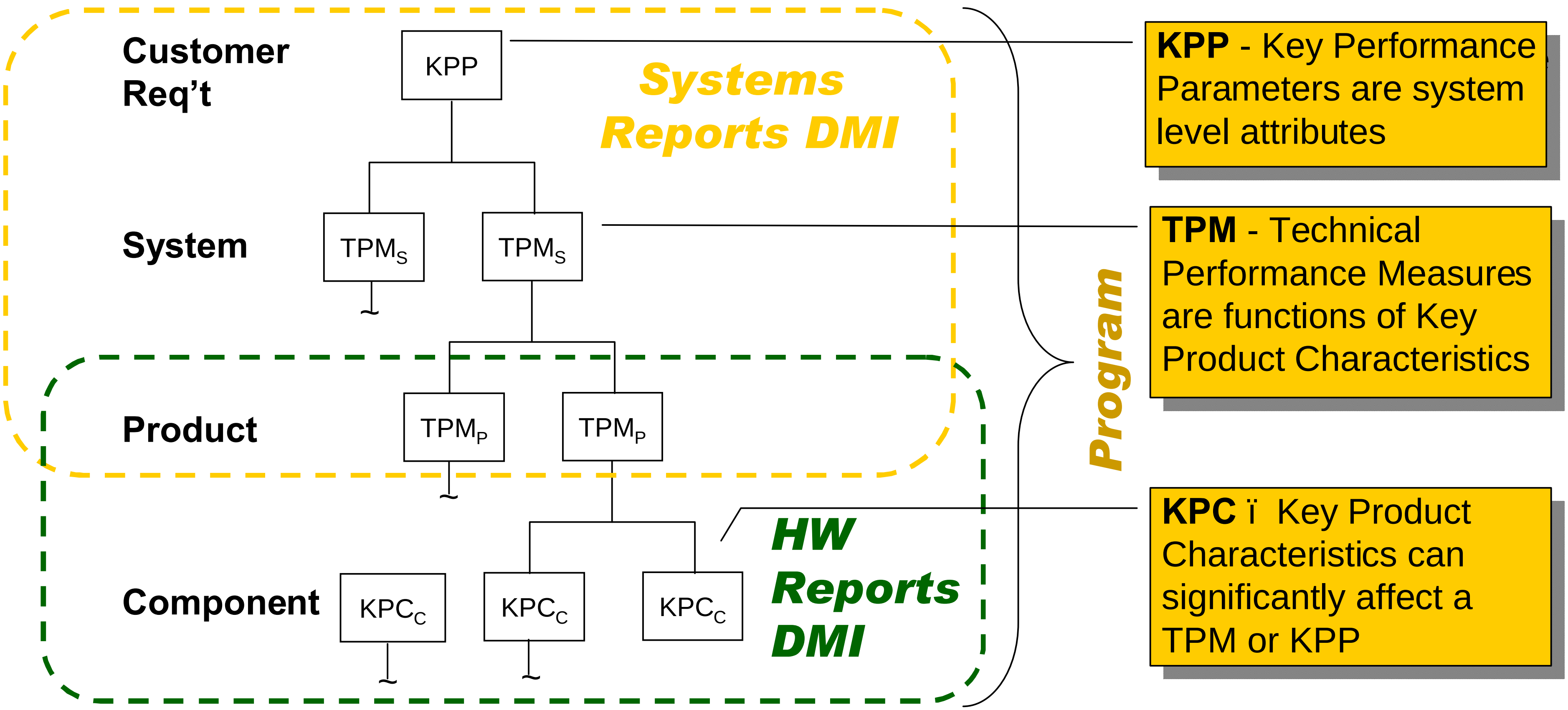
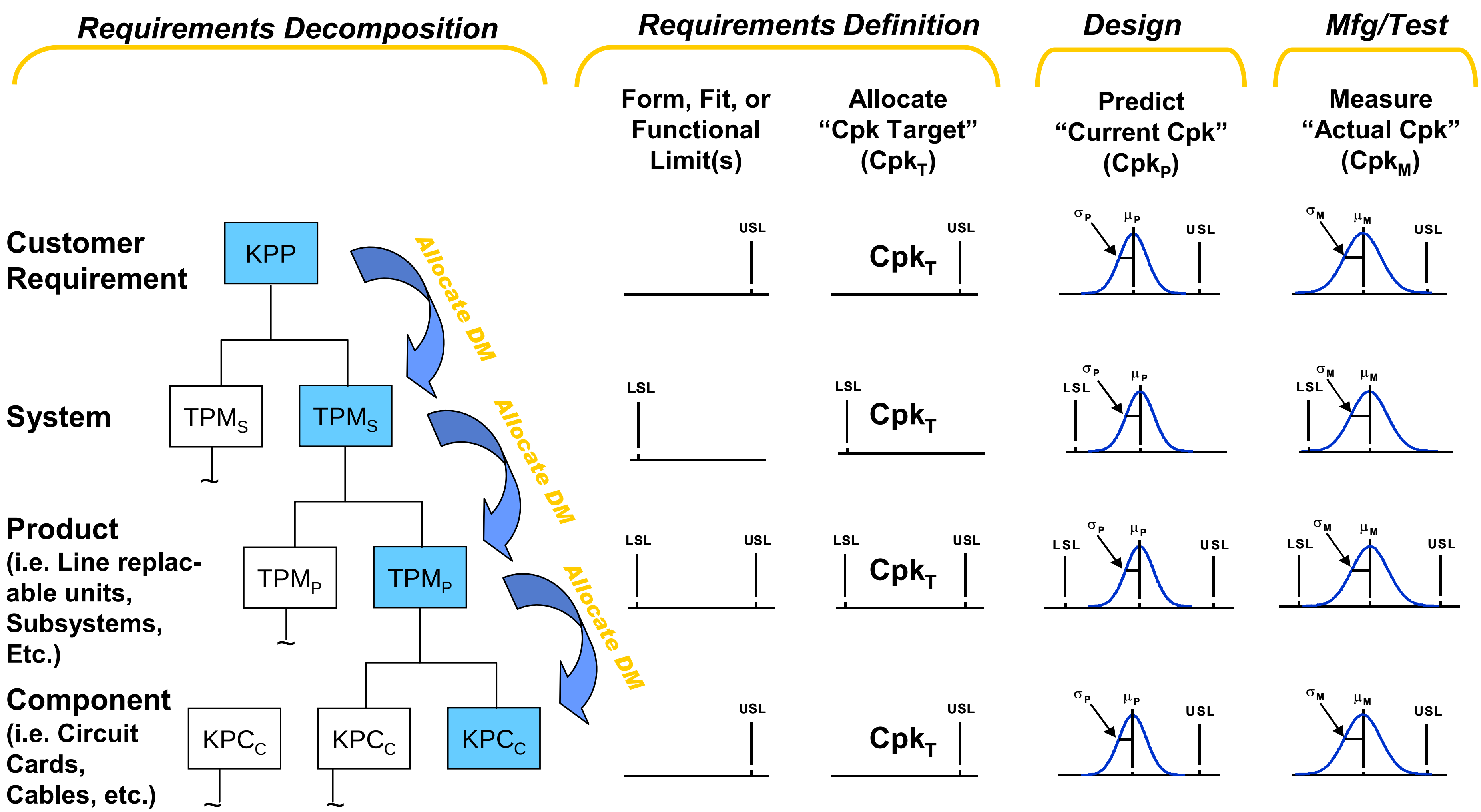


- **KPPs are decomposed into objectives and managed at lower levels to ensure program success**
- **DMI is an <u>index</u> used to measure the <u>design margin</u>**
- **DMI is a useful measure for assessing "over" design and "under" design**

Analysis:
over Program Life Cycle



- TPMs are used for quantitative management and statistical control
- This gives the programs added value and can help significantly reduce program costs

Analysis & Review: tative Management Stakeholders

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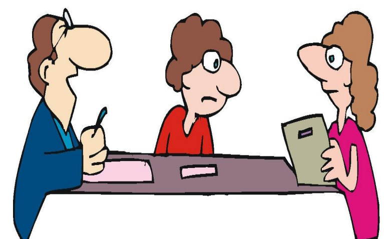
Program Engineer and Discipline Teams

NCS Engineering Process Steering Team

NCS Measurement Council

Engineering Councils

Site Measurement Teams



Engineering Management

- High level teams and managers were very interested is analyzing and reviewing measurement data
- This created a positive “pull” for information across NCS

Analysis & Review:
s and Review Flow

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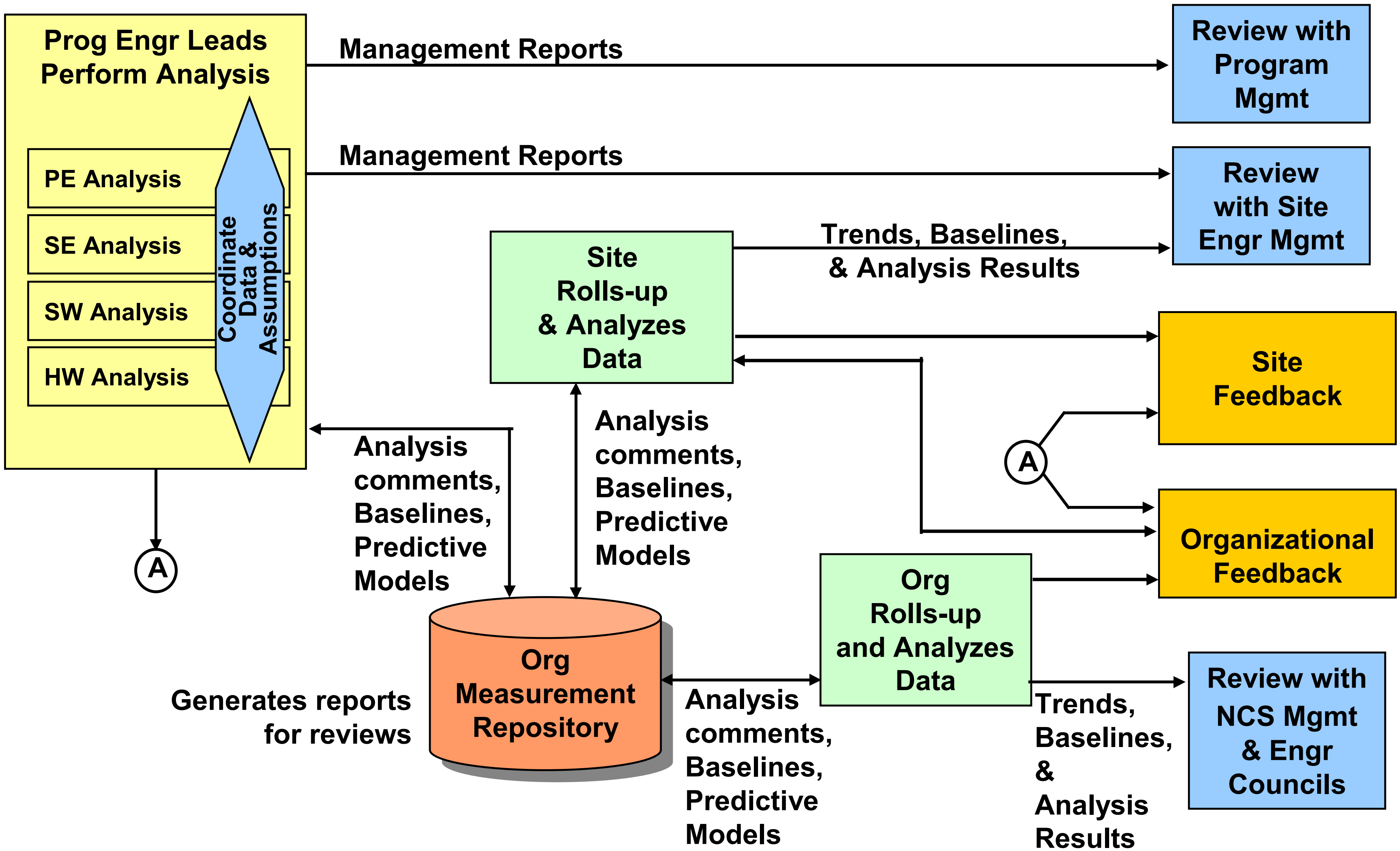

Consistent flow across NCS sites and disciplines

Tooling: omate Databases and Tools

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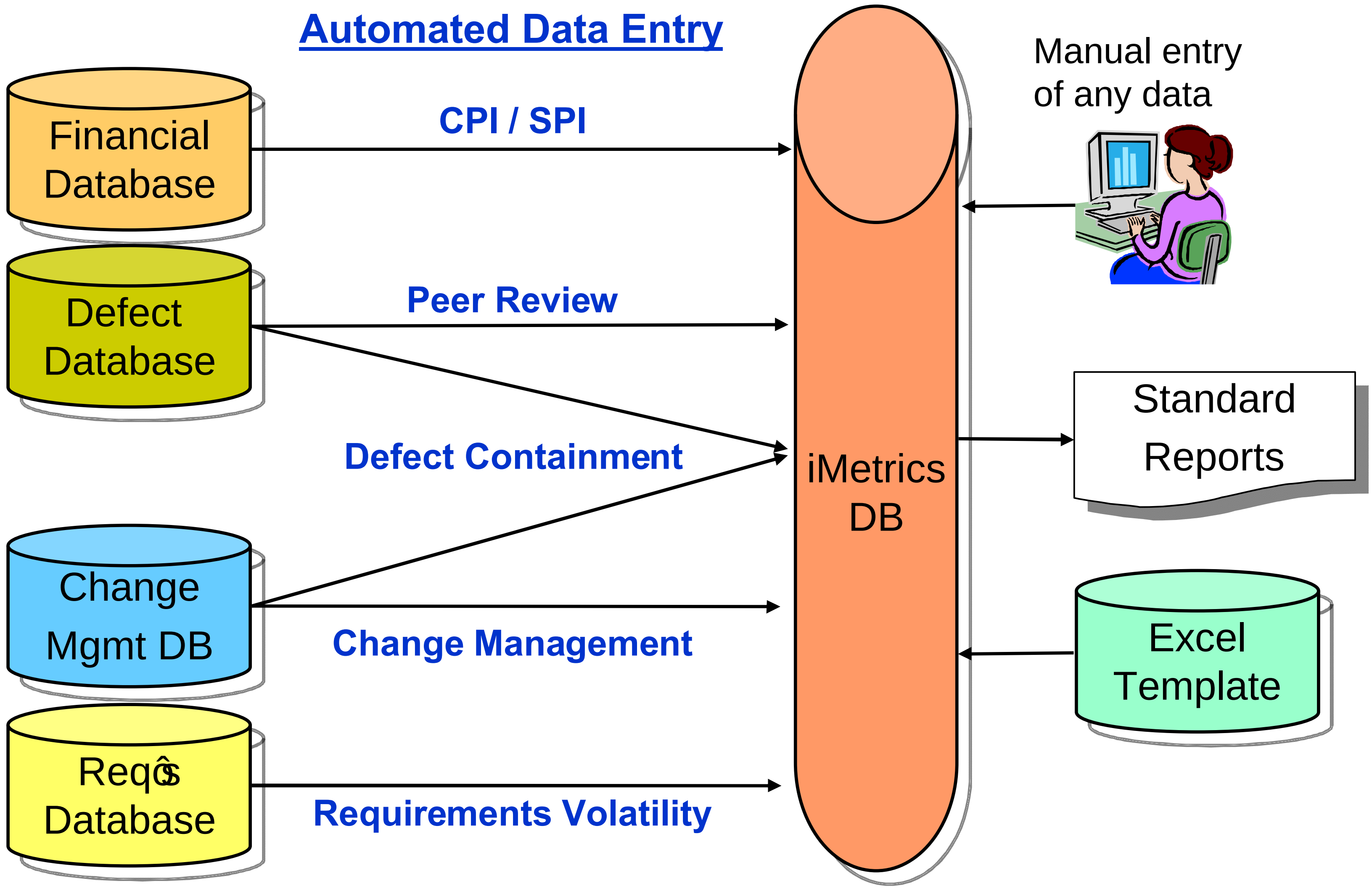

Automation allows repeatable quick entry of data tools to supply measurement data!

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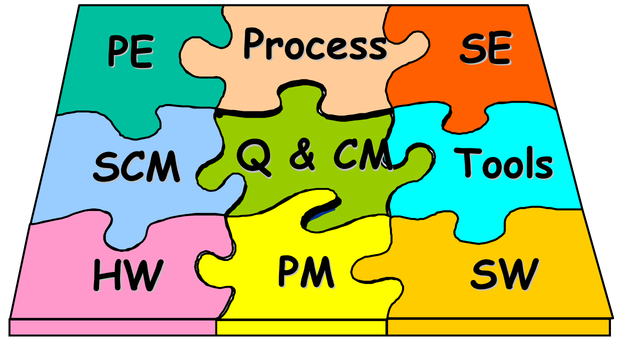
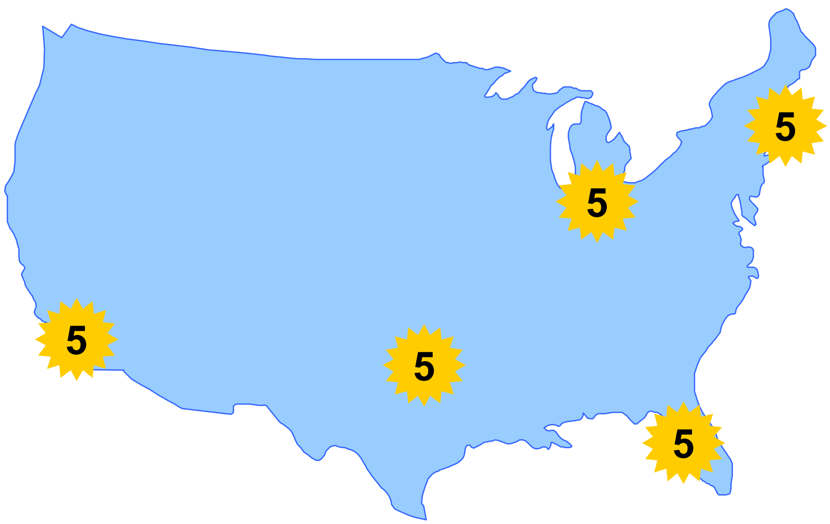
unities

- Increase the coverage and use of common cost collection codes to more disciplines and activities
- Extend use of measurement database to other roll-up management measures such as Oregon Productivity Matrixes (OPMs)
- Incorporate statistical and textual analysis capability into the measurement reporting automation
- Improve alignment of financial processes and tooling with the common cost collection codes
- Define collection scheme for the Incremental Development life cycle model
- Continue to broaden the scope of automation that supports collection and reporting or measures

Raytheon NCS deploys integrated processes with measures across multiple disciplines and sites to an engineering org of over 5,000 !!!





Raytheon NCS Achieves CMMI Level 5 on 1 June 2007 for Systems, Software, and Hardware Engineering !

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QUESTIONS ?

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Statistical Process Control Applied to Software Requirements Specification Process

Al Florence

The MITRE Corporation

The author's affiliation with The MITRE Corporation is provided for identification purposes only, and is not intended to convey or imply MITRE's concurrence with, or support for, the positions, opinions or view points expressed by this author.

Overview

- Introduction
  - » Background of Statistical Process Control
- Overview of Software Engineering Institute
  - » Capability Maturity Model Integration
  - » Quantitative Project Management and related Process Areas
- Statistic Process Control
  - » Overview of Control Charts
- Examples of Control Charts
  - » Applied to the Requirements Specification Process
- Conclusion
- Contact Information
- Acronyms/Abbreviations

Introduction

- Statistical Process Control (SPC) has been applied to manufacturing processes very effectively for many years.
- Recently software organizations, with higher process maturity levels, have started to apply SPC to their software development processes.
- Applying SPC to requirements efforts sets the stage for applying it to subsequent development activities.
- This may provided the biggest pay-off since most problems in software engineering can be directly traced to improper definition and specification of requirements.

Software Engineering Institute CMMI® (1 of 2)

- Capability Maturity
- CMMI® Level 4 - Quantitative Project Management
  - » SG 2 Statistically Manage Sub-process Performance
    - > The performance of selected sub-processes within a project's defined process is statistically managed.
      - SP 2.1 Select Measures and Analytic Techniques
      - SP 2.2 Apply Statistical Methods to Understand Variation
      - SP 2.3 Monitor Performance of the Selected Sub-processes
      - SP 2.4 Record Statistical Management Data

CMMI is a registered trademark of the SEI

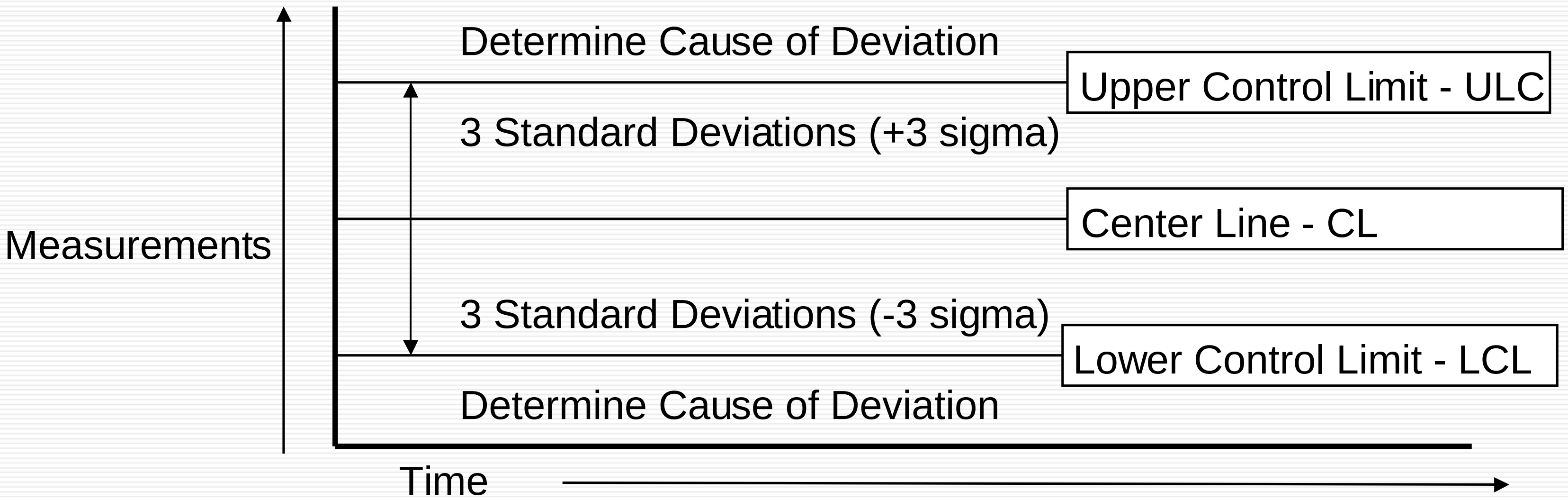
Software Engineering Institute CMMI® (2 of 2)

- CMMI® Other Process Areas
- CMMI® Level 5 - Causal Analysis and Resolution
  - » SG 1 Determine Causes of Defects
    - > Root causes of defects and other problems are systematically determined.
      - SP 1.1 Select Defect Data for Analysis
      - SP 1.2 Analyze Causes
  - » SG 2 Address Causes of Defects
    - > Root causes of defects and other problems are systematically addressed to prevent their future occurrence.
      - SP 2.1 Implement the Action Proposals
      - SP 2.2 Evaluate the Effect of Change
      - SP 2.3 Record Data

Statistical Process Control

- The intent of SPC:
  - » Is to better understand and monitor process behavior and to bring it under control when required.
  - » Is not necessarily to monitor products per se, although this may be a by-product of SPC.

Control Charts (1 of 9)



- According to the normal distribution, 99% of all normal random values lie within +/-3 standard deviations from the norm
- If a process is under Statistical Process Control, all measurements should fall within the 3-sigma limits
- If not, the anomaly needs to be investigated for cause and the process brought back under control

Control Charts (2 of 9)

- Control charts:
  - » Separate signal from noise
    - > so when anomalies occur they can be recognized
  - » Identify undesirable trends
    - > they point out:
      - Fixable problems
      - Potential process improvements
  - » Show the capability of the process
    - > so achievable goals can be set
  - » Provide evidence of process stability
    - > which justifies predicting process performance

Control Charts (3 of 9)

- Control charts use two types of data:
  - » variables data
  - » attributes data
- Variables data are usually measurements of continuous phenomena such as:
  - » elapsed time
  - » effort expended
  - » memory/CPU utilization

Control Charts (4 of 9)

- Attributes data are usually measurements of discrete phenomena such as:
  - number of defects
  - number of source statements
  - number of people
- Most measurements in software used for SPC are attributes data.

Control Charts (5 of 9)

- The following are control charts that should be used for variables data and for attributes data:
  - Attributes Data
    - u charts
    - Z charts
    - XmR charts
  - Variables Data
    - X-bar charts
    - R charts
    - XmR charts

Control Charts (6 of 9)

- u charts are used when the data are samples from:
  - » a Poisson distribution, and
  - » the areas of opportunity are not constant
- Z charts can be used to avoid variable control limits for both large and small variations

Control Charts (7 of 9)

- XmR charts can be useful
  - » when little is known about the underlying distribution, or
  - » when the justification for assuming a binomial or Poisson process is questionable
- X-bar and R charts are used to portray process behavior when you have the option of collecting multiple measurements within a short period of time under basically the same conditions

Control Charts (8 of 9)

- Other sigma limits for homogeneous sets of data (The Empirical Rule)
  - » 1 sigma
    - > Roughly 60% to 70% of data will be located within 1 sigma
  - » 2 sigma
    - > Roughly 90% to 98% of data will be located within 2 sigma
  - » 3 sigma
    - > Roughly 99% to 100% of data will be located within 3 sigma

Control Charts (9 of 9)

- Tests for out-of control situations
  - Test 1
    - A single point falls outside the 3-sigma control limits
  - Test 2
    - At least 2 out of 3 successive points fall on the same side of, and more that 2-sigma units from, the center line
  - Test 3
    - At least 4 out of 5 successive points fall on the same side of, and more that 1-sigma unit from, the center line
  - Test 4
    - At least 8 successive values fall on the same side of the center line

Project Examples (1 of 2)

- A government agency, while re-developing legacy systems, reverse engineered the existing software requirements
- Five teams were assigned to reverse engineer related sets of functional requirements
- This author was assigned as a consultant to support the agency in the proper specification of the requirements

Project Examples (2 of 2)

- The examples illustrate:
  - » the proper specification of requirements
    - > Specification in this context means “writing” the requirements
  - » the application of control charts applied to the requirements specification process

Attendee Participation

What is wrong with this requirement?

After the system receives the Validation file, the system shall:

- notify the individual about acceptance or rejection.
- the acceptance file must contain the name and ZIP code of the individual.
- rejected validation request must include the Reason Code.

Criteria for Specifying a Good Requirement (1 of 4)

- The following are some critical attributes that requirements must adhere to:

  (used to critique the requirements)

- Completeness: Requirements should be complete
  - » They should reflect system objectives and specify the relationship between the software and the rest of the subsystems
- Consistency: Requirements must be consistent with each other; no requirement should conflict with any other requirement
  - » Requirements should be checked by examining all requirements in relation to each other for consistency and compatibility

Criteria for Specifying a Good Requirement (2 of 4)

- Feasibility: Each requirement must be feasible to implement
  - » Requirements that have questionable feasibility should be analyzed during requirements analysis to prove their feasibility
- Traceability: Each requirement must be traceable to some higher-level source, such as a system- level requirement
  - » Each requirement should also be traced to lower level design and test abstractions such as high-level and detailed-level design and test cases

Criteria for Specifying a Good Requirement (3 of 4)

- Testability: All requirements must be testable in order to demonstrate that the software end product satisfies its requirements
  - » In order for requirements to be testable they must be specific, unambiguous, and quantitative whenever possible. Avoid negative, vague and general statements
- Unique identification: Uniquely identifying each requirement is essential if requirements are to be traceable and testable
  - » Uniqueness also helps in stating requirements in a clear and consistent fashion

Criteria for Specifying a Good Requirement (4 of 4)

- Design Free: Software requirements should be specified at a requirements level not at a design level
  - » The approach should be to describe the software requirement functionally from a system (external) point of view, not from a software design point-of-view, i.e. describe the system functions that the software must satisfy.
- Use of "shall" and related words: In specifications, the use of the word "shall" indicates a binding provision
  - » Binding provisions must be implemented by users of specifications. To state non-binding provisions, use "should" or "may". Use "will" to express a declaration of purpose (e.g., "The Government will furnish..."), or to express future tense. MIL-STD-490A

Background

- It needs to be noted that requirements do not "live alone"
  - » They depend on other requirements and/or
  - » on clarifying comments

    to present a complete view of the functionality associated with a related set of requirements.
- A related set of functional requirements may be introduced with a preamble describing the capability of the functional set.
  - » The preamble does not itself establish requirements; this is done later in the requirements' specifications.
- Some requirements may be amplified with clarifying comments which are, again, not part of the requirements, but add understandability.

Background

- Some requirements are documented sequentially with the requirements stated first setting the “stage” for the following requirements which add more and more capability.
  - » The later stated requirements depend on the earlier requirements to complete their functionally.
  - » An example may be the use of the word “processing”. If the processing of a functional set of related requirements has been described in earlier requirements the later requirements may amplify and/or reference the processing without having to restate the processing.
- This is the case in the following examples; they have been extracted from a larger set of functionally related requirements and may not present a complete picture of the entire set.
- If a single requirement was to be a complete picture of a complex capability, one requirement would have to describe the entire capability making it extremely complex and difficult to understand, implement, and test.

Background

- The first set of requirements were received from the teams before they had been exposed to the critical attributes while the subsequent sets were received after they had incorporated review comments and had been trained on using the attributes.
- Later sets of requirements still had defects which were detected in subsequent critiques and used to create the control charts related to those iterative sets.
  - » This continued for several months until it was felt that the process was under statistical process control and that requirements were well specified.
  - » Because of this some readers may want to find additional issues associated with these examples, other than the ones listed in the critiques.
  - » Also, there may be issues with the re-specifications, but keep in mind that these hopefully would be identified in subsequent critiques.

Examples (1 of 2)

- The following examples illustrate the application of SPC to the process of specifying requirements
- The first two examples show some requirements
  - » As initially specified by the teams
  - » Followed by this authors critique against the critical attributes of requirements
  - » The re-specification of the requirements

Each violation against the critical attributes will be recorded as a defect to be used to construct control charts.

Examples (2 of 2)

- The next three examples show control charts applied to the specification of the requirements
  - » The first control chart example depicts the requirements specification process as being out of statistical process control
  - » The next control chart shows the process on the path towards being brought under control
  - » The third one shows the process under statistical process control

Example 1 (1 of 2)

- Initial specification:

  3.4.6.3 The system shall prevent processing of duplicate electronic files by checking the SDATE record. An e-mail message shall be sent.

- Critique:

1. Two "shalls" under one requirement number.
2. When is the SDATE record checked?
3. Against what other records is the SDATE record checked?
4. What is checked in the SDATE record?
5. To whom is the email message sent?
6. What does the email message say?
7. When is the email message sent?
8. The requirement has design implications, SDATE record.
   - A requirement should specify what the data in the record are and not the name of the record as it exists in the design and implementation

8 critical attributes violations (defects)

Example 1 (2 of 2)

- Re-specification:

  3.4.6.3 The system shall:

  a. Prevent processing of duplicate electronic files by immediately checking the date and time of the submission against prior submissions, and

  b. Immediately send the following e-mail message to submitter:

     1. Request updated submission date and time, if necessary, and
     2. State that the submission was successful, when successful.

Example 2 (1 of 2)

- Initial specification:
- After the system receives the Validation file, the system shall:
  - » Notify the individual about acceptance or rejection
  - » The acceptance file must contain the name and ZIP code of the individual
  - » Rejected validation request must include the Reason Code
- Critique:
  1. The second and third bullets don't make sense, try to read them as such:
     - > the system shall the acceptance file must...
     - > the system shall rejected validation…
  2. Use of both "shall" and "must"
  3. Where are the reason codes?
  4. Who is notified?
  5. How is the individual notified?
  6. No unique identifier
  7. Use of bullets, bullets are difficult to trace

7 critical attributes violations (defects)

Example 2 (2 of 2)

- Re-specification:

  3.2.7.3 When the system receives a validation file, the system shall:

  a. Reject the file if it does not contain the individual's
     1. name, and
     2. ZIP code, and

  b. Notify the individual via electronic transmission about acceptance or rejection with a reason code for rejection. (Reference Reason Code, Table 5.4.8), and

  c. Request corrected resubmission, if rejected.

Example 3 (1 of 4)

Out of Statistical Process Control

- Example 3 will show a control chart of all teams' attempts at the initially specification of the requirements
- This was before they received guidance on the critical attributes

Raw data collected from the initial specification of the requirements

Teams	No. Rqmts	Defects	*DefectsX100/ No of Rqmts
1	105	305	290.48
2	134	172	128.36
3	98	105	107.15
4	201	205	101.16
5	196	407	207.66
Totals	734	1194	

**Defects normalized to 100 requirements*

Example 3 (2 of 4)

Calculations to be used to construct the control chart

- Plot = Number of defects X 100 / requirements specified [calculated for each team's data]
- CL = (total number of defects/total number of requirements) X 100
- UCL = CL+3(SQRT(CL/a1) [calculated for each team's data]
- LCL = CL-3(SQRT(CL/a1) [calculated for each team's data]
- a1= Requirements specified/100 [calculated for each team's data]

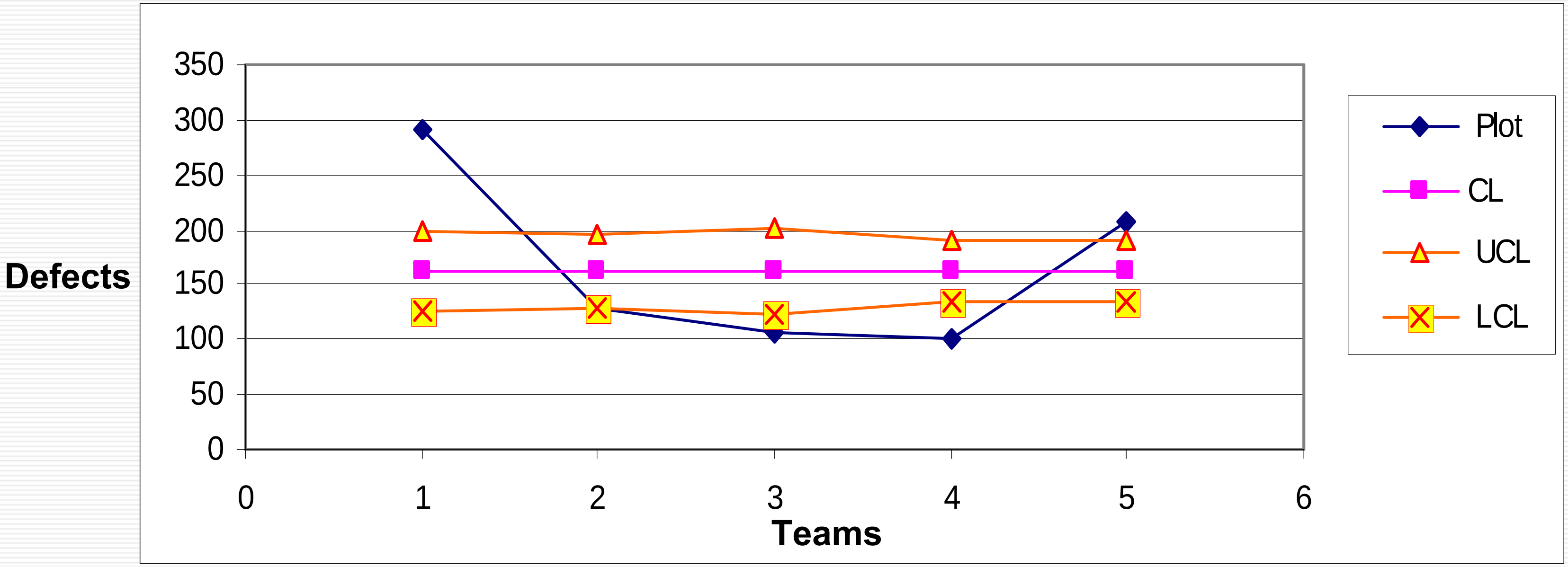
Example 3 (3 of 4)

Calculations to be used to construct the control chart

Teams	Plot	CL	UCL	LCL	a_1
1	290.48	162.67	200.01	125.33	1.05
2	128.36	162.67	195.72	129.62	1.34
3	107.15	162.67	201.32	124.03	0.98
4	101.10	162.67	189.66	135.68	2.01
5	207.66	162.67	190.00	135.34	1.96

Example 3 (4 of 4)

Control Chart for the Initial Specification of Requirements



- For control charts to be valid, they need to be used on processes that are mature and conducted consistently and on measurements that are valid, i.e. correctly depict the process
- This control chart showed that the process was immature and out of statistical process control
- The teams had not received guidance on the critical attributes of requirements, i.e., were not following a consistent process

Example 4 (1 of 3)

Toward Being Brought Under Statistical Process Control

- Example 4 will show a control chart of all teams' subsequent attempts at the specification of the requirements. New sets of requirements were included.
- The teams had been trained in the critical attributes and most had resolved the critique issues

Example 4 (2 of 3)

Raw Data

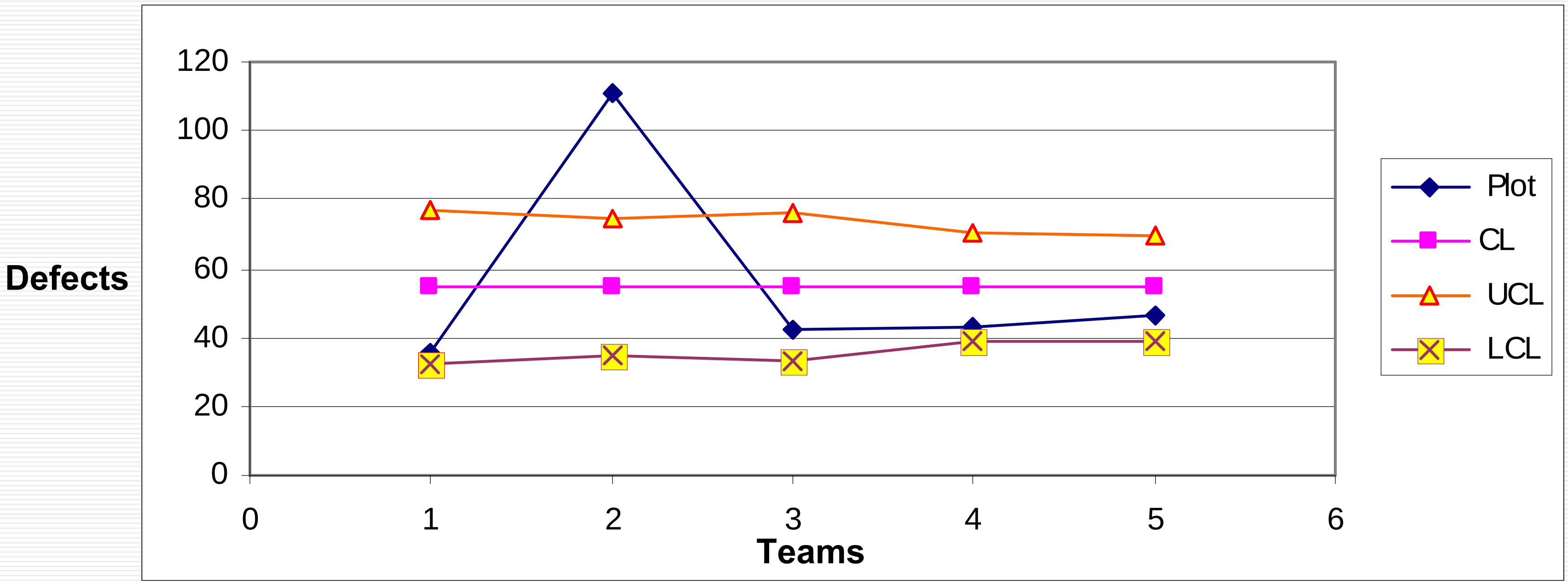
Teams	No. Rqmts	Defects	DefectsX100/ No. of Rqmts
1	98	35	35.71
2	125	139	111.20
3	107	45	42.06
4	198	85	42.93
5	205	95	46.34
Totals	733	399	

Calculations

Teams	Plot	CL	UCL	LCL	a_1
1	35.71	54.43	76.79	32.08	0.98
2	111.20	54.43	74.23	34.64	1.25
3	42.06	54.43	75.83	33.04	1.07
4	42.93	54.43	70.16	38.70	1.98
5	46.34	54.43	69.89	38.97	2.05

Example 4 (3 of 3)

Control Chart for Subsequent Specification of Requirements



An anomaly occurred with the second team's effort

Causal analysis revealed that the second team had not implemented the critique's findings nor analyzed new requirements against the critical attributes.

Example 5 (1 of 3)

Under Statistical Process Control

- Example 5 will show a control chart of all teams' subsequent attempts at the specification of the requirements. New sets of requirements were included.
- Management ensured that the second team resolved the issues identified in the critique and that they analyze additional requirements against the critical attributes.

Example 5 (2 of 3)

Raw Data

Teams	No. Rqmts	Defects	DefectsX100/ No. of Rqmts
1	105	2	1.90
2	116	4	3.45
3	101	6	5.94
4	205	9	4.39
5	298	14	4.70
Totals	825	35	

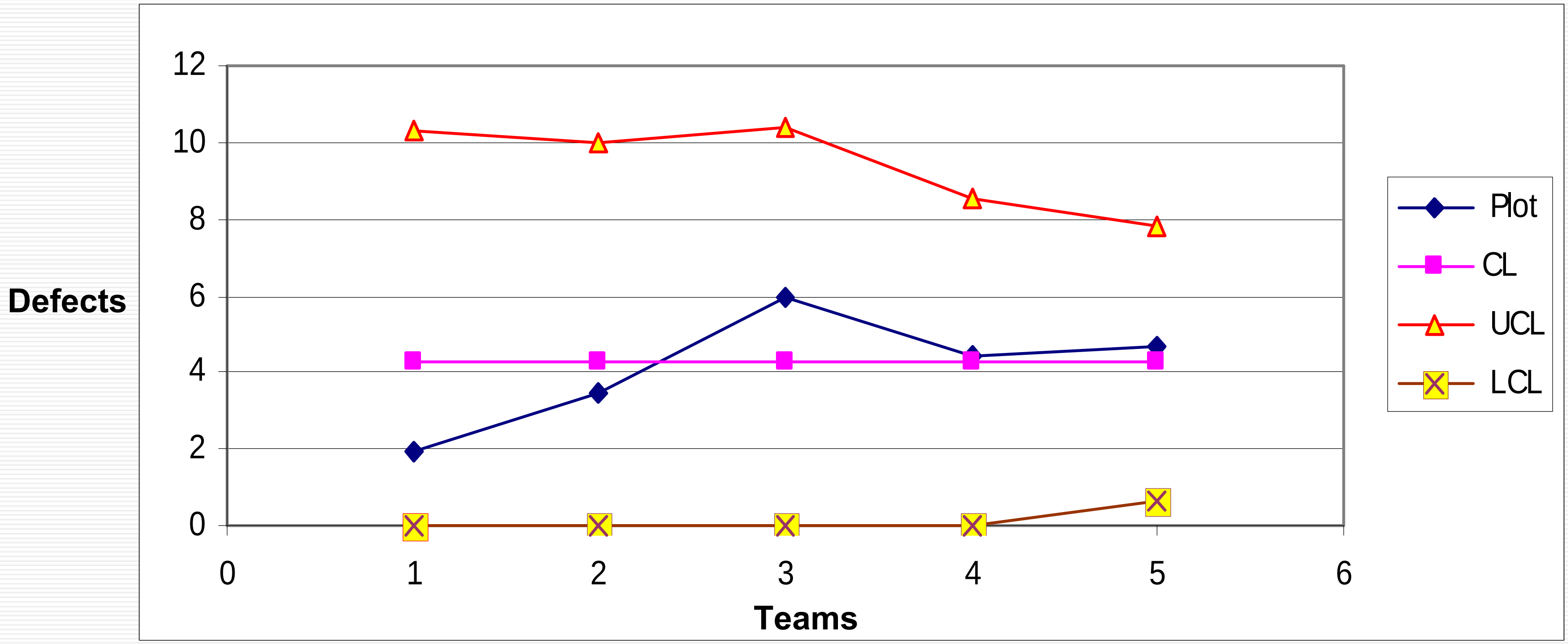
Calculations

Teams	Plot	CL	UCL	LCL	a_1
1	1.90	4.24	10.27	0	1.1
2	3.45	4.24	9.98	0	1.2
3	5.95	4.24	10.40	0	1
4	4.40	4.24	8.56	0	2.1
5	4.70	4.24	7.82	0.66	3

When the LCL is negative it is set to zero.

Example 5 (3 of 3)

Control Chart for Subsequent Specification of Requirements

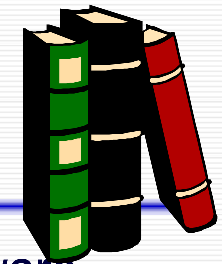


The requirements specification process is, for now, under statistical process control.

Conclusion

- The examples demonstrate the use of SPC applied to the requirements specification process. Many more control charts were constructed and analyzed. The ones use here were selected to succinctly demonstrate their use.
- The use of statistics using SPC control charts and other statistical methods can easily and effectively be used in a software setting. SPC can identify undesirable trends and can point out fixable problems and potential process improvements and technology enhancements.
- Using SPC, beginning with requirements analysis, can provide the biggest payoff. It is a well-known fact that if requirements are properly defined early in the development life cycle, the migration of problems into the later phases will be mitigated.

References and Suggested Readings (1 of 2)



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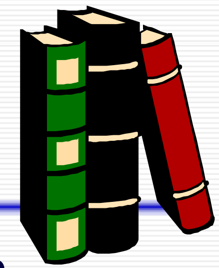

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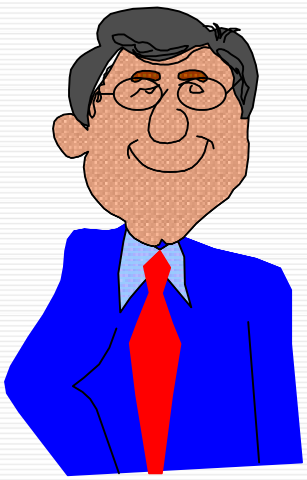
Contact Information



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Abbreviations

- CL - Center Line
- CMMI® - Capability Maturity Model Integration
- ET - Eastern Time
- FA - Financial Agent
- LCL - Lower Control Limit
- SPC - Statistical Process Control
- UCL - Upper Control Limit

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Using the Scientific Method to Achieve Level 4 and 5

Inferential Statistical Models and their Relationship to CMMI Levels 4 and 5

Jeff N. Ricketts, Ph.D.

…od and inferential …ed

The scientific method is a body of techniques for investigating phenomena, acquiring new knowledge, or correcting and integrating previous knowledge. It is based on gathering observable, empirical and measurable evidence subject to specific principles of reasoning. The scientific method consists of the collection of data through observation and experimentation, and the formulation and testing of hypotheses. The scientific method is used to explain and predict the causes of variability in natural phenomena.

Inferential statistics or statistical induction comprises the use of statistics to make inferences concerning relationships within a population. These relationships are expressed in causal terms

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Current state

General Measurement Issues

Burning Platform

Measurement in the Model

Steps in the Scientific Method

More issues

Example Statistical Model

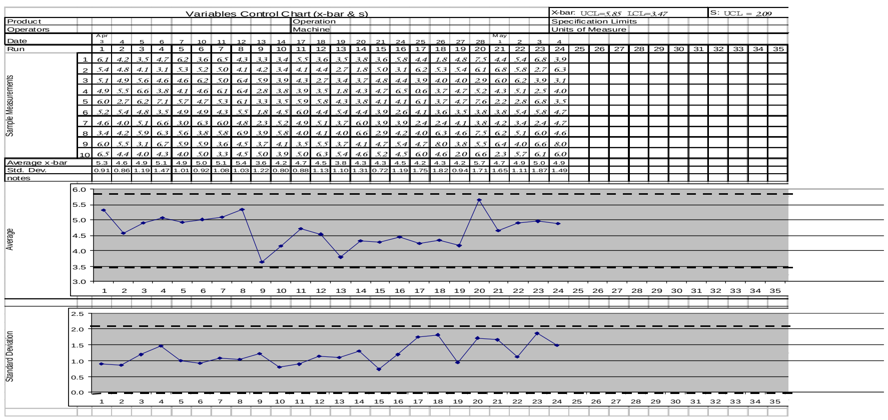
Summary

f the Practice

Engineering Measures:

- Staffing
- CPI/SPI
- Defect Density
- Defect Containment
- Problem Report Open and Closure status
- Requirements Volatility
- Stoplight Charts

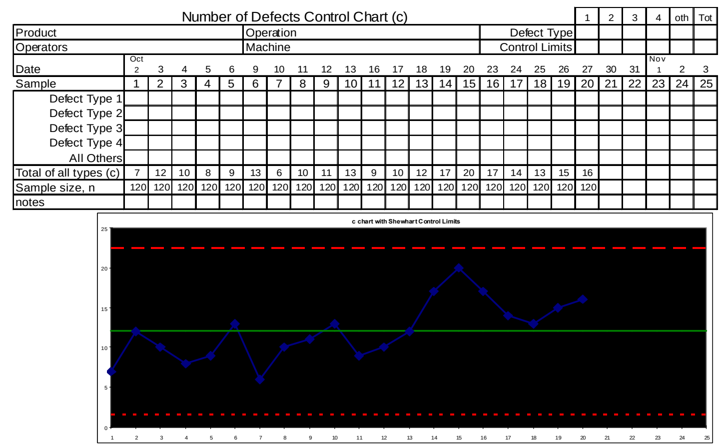
eering Review Charts



Variables Control Chart (x-bar & s)

Product	Operation	X-bar: UCL=5.85 LCL=3.47	S: UCL = 2.09
Operators	Machine	Specification Limits	
		Units of Measure	

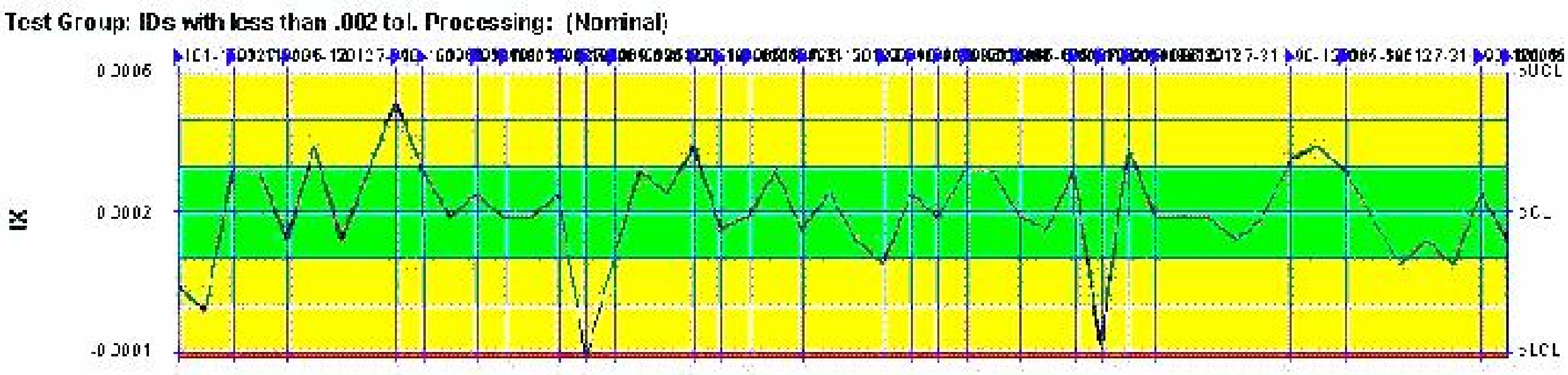
Run	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Date	Apr 3	4	5	6	7	10	11	12	13	14	17	18	19	20	21	24	25	26	27	28	May 1	2	3	4											
Sample Measurements 1	6.1	4.2	3.5	4.7	6.2	3.6	6.5	4.3	3.3	3.4	5.5	3.6	3.5	3.8	3.6	5.8	4.4	1.8	4.8	7.5	4.4	5.4	6.8	3.9											
2	5.4	4.8	4.1	3.1	5.3	5.2	5.0	4.1	4.2	3.4	4.1	4.4	2.7	1.8	5.0	3.1	6.2	5.3	5.4	6.1	6.8	5.8	2.7	6.3											
3	5.1	4.9	5.6	4.6	4.6	6.2	5.0	6.4	5.9	3.9	4.3	2.7	3.4	3.7	4.8	4.4	3.9	4.0	4.0	2.9	6.0	6.2	3.9	3.1											
4	4.9	5.5	6.6	3.8	4.1	4.6	6.1	6.4	2.8	3.8	3.9	3.5	1.8	4.3	4.7	6.5	0.6	3.7	4.7	5.2	4.3	5.1	2.5	4.0											
5	6.0	2.7	6.2	7.1	5.7	4.7	5.3	6.1	3.3	3.5	5.9	5.8	4.3	3.8	4.1	4.1	6.1	3.7	4.7	7.6	2.2	2.8	6.8	3.5											
6	5.2	5.4	4.8	3.5	4.9	4.9	4.3	5.5	1.8	4.5	6.0	4.4	5.4	4.4	3.9	2.6	4.1	3.6	3.5	3.8	3.8	5.4	5.8	4.7											
7	4.6	4.0	5.1	6.6	3.0	6.3	6.0	4.8	2.3	5.2	4.9	5.1	3.7	6.0	3.9	3.9	2.4	2.4	4.1	3.8	4.2	3.4	2.4	4.7											
8	3.4	4.2	5.9	6.3	5.6	3.8	5.8	6.9	3.9	5.8	4.0	4.1	4.0	6.6	2.9	4.2	4.0	6.3	4.6	7.5	6.2	5.1	6.0	4.6											
9	6.0	5.5	3.1	6.7	5.9	5.9	3.6	4.5	3.7	4.1	3.5	5.5	3.7	4.1	4.7	5.4	4.7	8.0	3.8	5.5	6.4	4.0	6.6	8.0											
10	6.5	4.4	4.0	4.3	4.0	5.0	3.3	4.5	5.0	3.9	5.0	6.3	5.4	4.6	5.2	4.5	6.0	4.6	2.0	6.6	2.3	5.7	6.1	6.0											
Average x-bar	5.3	4.6	4.9	5.1	4.9	5.0	5.1	5.4	3.6	4.2	4.7	4.5	3.8	4.3	4.3	4.5	4.2	4.3	4.2	5.7	4.7	4.9	5.0	4.9											
Std. Dev.	0.91	0.86	1.19	1.47	1.01	0.92	1.08	1.03	1.22	0.80	0.88	1.13	1.10	1.31	0.72	1.19	1.75	1.82	0.94	1.71	1.65	1.11	1.87	1.49											
notes																																			



Number of Defects Control Chart (c)

			1	2	3	4	oth	Tot
Product	Operation	Defect Type						
Operators	Machine	Control Limits						

Sample	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Date	Oct 2	3	4	5	6	9	10	11	12	13	16	17	18	19	20	23	24	25	26	27	30	31	Nov 1	2	3
Defect Type 1																									
Defect Type 2																									
Defect Type 3																									
Defect Type 4																									
All Others																									
Total of all types (c)	7	12	10	8	9	13	6	10	11	13	9	10	12	17	20	17	14	13	15	16					
Sample size, n	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120					
notes																									



Run charts for CPI/SPI/RVOL etc

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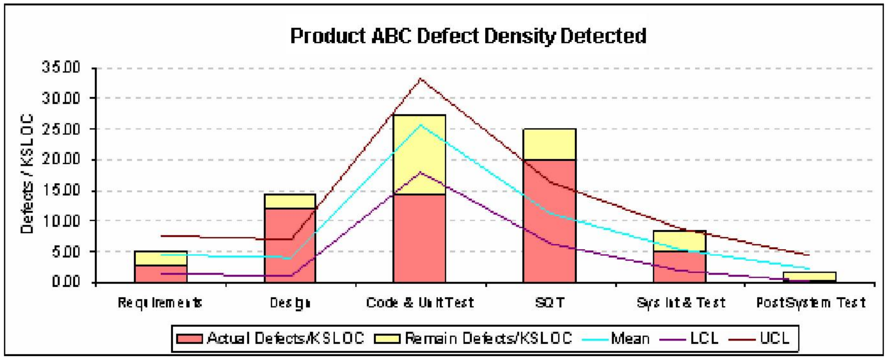
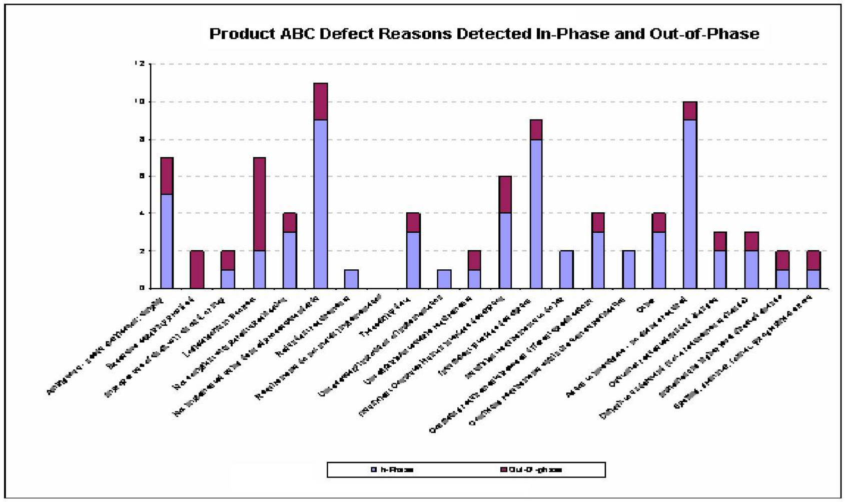
eering Review Charts

	Baseline	System Requirements and Architecture	Product Requirements and Architecture	Requirements Analysis	Preliminary Design	Detailed Design	Implementation	Integration	Product Verification and Validation	System Integration	System Acceptance Test	System Field Test	Production and Deployment	Operations and Support	Total
Baseline	0														0
System Requirements and Architecture	0	1													1
Product Requirements and Architecture	3	3	4												10
Requirements Analysis	2	2	23	3											30
Preliminary Design	3	2	2	2	2										11
Detailed Design	1	11	1	1	1	11									26
Implementation	0	0	0	0	0	0	0								0
Integration	0	0	0	0	0	0	0	3							3
Product Verification and Validation	0	0	0	0	0	0	0	0	0						0
System Integration	0	0	0	0	0	0	4	0	3	0					7
System Acceptance Test	0	0	0	0	0	0	0	0	2	0	2				4
System Field Test	0	0	0	0	0	0	0	3	0	0	0	1			4
Production and Deployment	0	0	0	0	0	0	0	0	0	0	0	0	3		3
Operations and Support	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	9	19	30	6	3	11	4	6	6	0	2	1	3	0	99

Defect Containment



Defect Density



Defect Types

eering Review Charts

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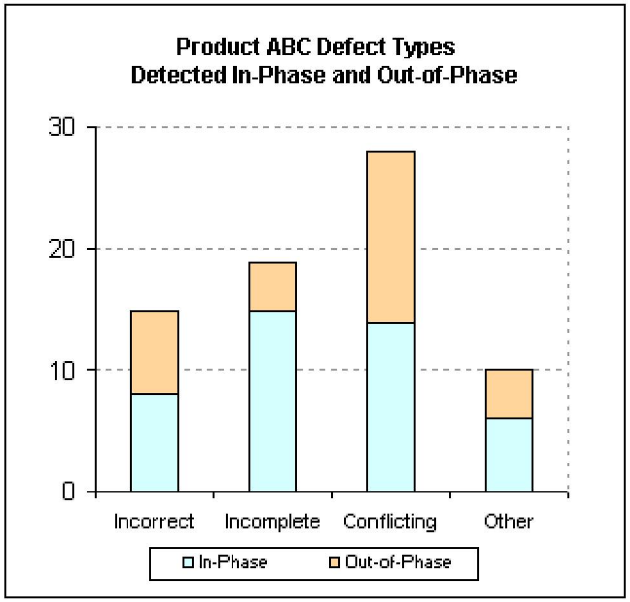
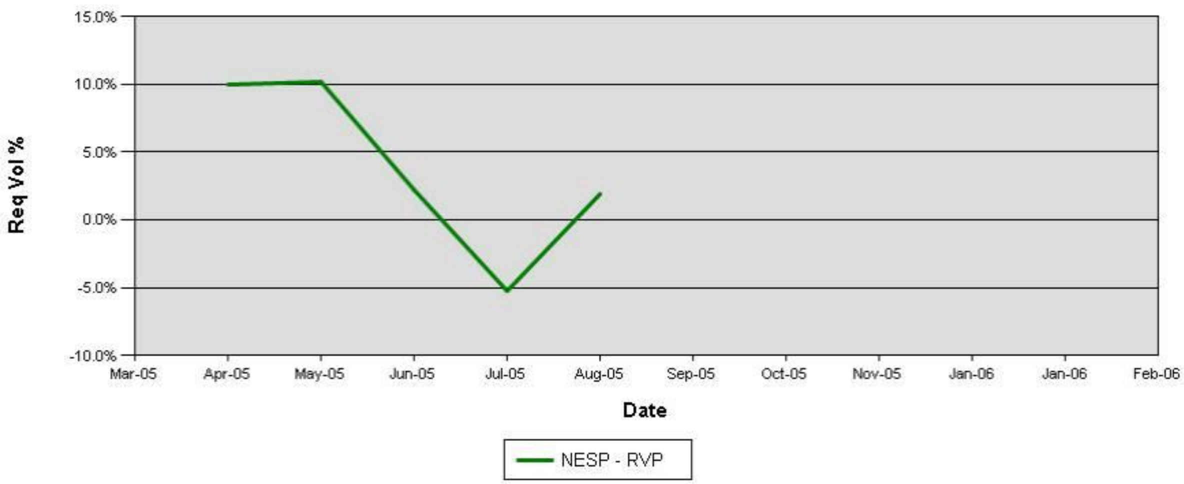


Defect type histogram

Requirements Volatility run chart



urement Issues

The standard measures commonly in use today all have one thing in common: they are historical vs. predictive

They are all reactive vs. proactive

Some metrics have little relationship with the real questions that need to be answered

Corrective actions are usually haphazard and unverifiable as to their effectiveness

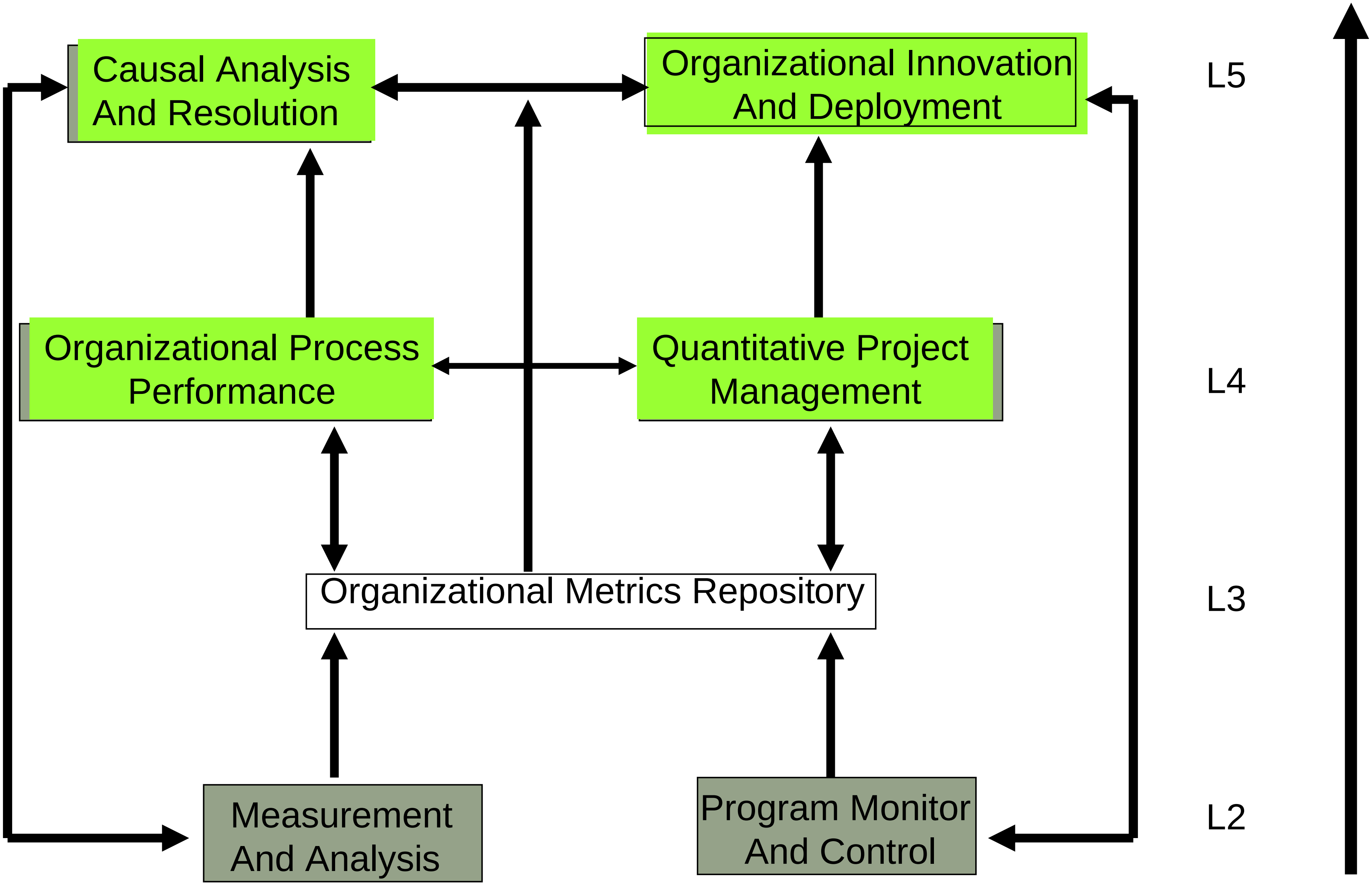
There are no standard measurement definitions

Platform

We need to do a better job applying scientific methods and inferential statistical models to our business to determine what causal relationships exist between the variables that we can control in order to optimize our processes and tools and reduce development costs

Level 4-5 processes can be optimized through the use of causal analysis and predictive measurement

ysis Spans the Model



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…nkage

QPM SG2- Statistically Manage Sub process Performance
- SP2.1 - Select Measures and Analytic Techniques
- SP2.2 - Apply Statistical Methods to Understand Variation
- SP2.3 - Monitor Performance of the Selected Sub processes
- SP2.4 - Record Statistical Management Data

OPP SP1.5 - Establish and maintain process performance models for the organizationôs set of standard processes

OID SG1 - Select Improvements
- SP1.3 - Pilot Improvements

CAR SG1 - Determine Causes of Defects
- SP1.1 - Select Defect data for Analysis
- SP1.2 - Analyze Causes

CAR SG2 - Address Causes of Defects
- SP2.1 - Implement Action Proposals
- SP2.2 - Evaluate the Effect of Changes

e Process

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The product development process consists of many variables (tools, people, processes, inputs, outputs)

There is a lot of variation in these factors and consequences of the variation:

stability of requirements
makeup of peer review teams
stability of design
types of tools and technology used
number of defects identified in peer reviews
amount of hrs of training per engineer
maturity of technology
types of development environments used
skill sets/mix
programming language or design methods used

ots
nditional associations)

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X seems to happen more often when Y is around

We always seem to do better when we use this product/method/tool/process

Do we really save time by conducting formal peer reviews for reused and ported code?

Are peer reviews even necessary on a product line?

Use cases take a long time to develop. Are they really necessary?

The key is to identify factors that appear to be associated with each other or are not reducing cost and schedule

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Null Hypotheses

If you suspect that there is a causal relationship between two variables, the relationship is stated in the form of "no difference".

e.g. Systems engineers find the same number of defects during peer reviews as software engineers.

e.g. The amount of preparation time one takes for a peer review has no relationship to the number of defects identified

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e Process

Measurements must be consistent, precise and repeatable

Measures are targeted for the type of statistics that will be generated

- Nominal - categorical/dichotomous- systems engineers vs. software engineers
- Ordinal - categorical -low medium high- complexity factors, lift/mod/reuse
- Interval - frequency distributions- 1é n - years of experience
- Ratio - frequency distributions with an absolute zero

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ategory of data

Nominal	Difference in proportions, Chi square, Lambda, studentôs t test
Ordinal	Analysis of Variance, Exactness tests, Rank Order correlation, Gamma
Interval	Correlation and regression, Multiple and stepwise regression, path analysis
Ratio	Correlation and regression, multiple and stepwise regression, path analysis

mple (test) Statistic

Samples must be representative of the population under study

Samples must be randomly selected (can be simple, stratified, cluster, etc)

Samples cannot be the whole population

Statistics computed must be appropriate for the level of measurement

heses

What is the observed difference between Group A and Group B?

What is the measure of association between the independent variable (X) and the dependent variable (Y)?

Significance levels tell you if the observed difference is statistically significant

Given no relationship between what you measured, this is the probability (.05, .01, .001) that you would observe this result in a randomly drawn sample from the population of this size?

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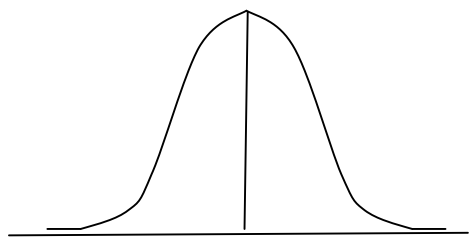
Important

Study 1

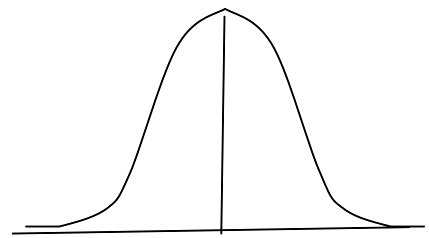


$$\bar{x}_1 - \bar{x}_2 = 0$$

$\bar{x}_1 = 14.25$ $\bar{x}_2 = 21.75$

$N_2 = 25$

Study 2



$$\bar{x}_1 - \bar{x}_2 = 0$$

$\bar{x}_1 = 30.0$ $\bar{x}_2 = 34.75$

$N_2 = 450$

Group 1 was composed only of requirements developers
Group 2 was composed of testers and requirements developers

Which observed difference between these groups is statistically significant given their sample sizes?

ment

What is a line of code?

What is a defect?

What is productivity?

What is rework?

What is a requirement?

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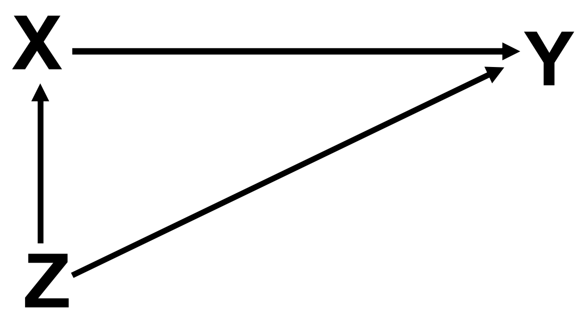
Typically not done

Typically not random

Samples need to be representative of the population that they are drawn from

rious Relationships



Changes in X appear to be causing changes in Y when in fact Z is associated with both X and Y so when Z varies both X and Y vary

riation in Integration SPI/CPI?

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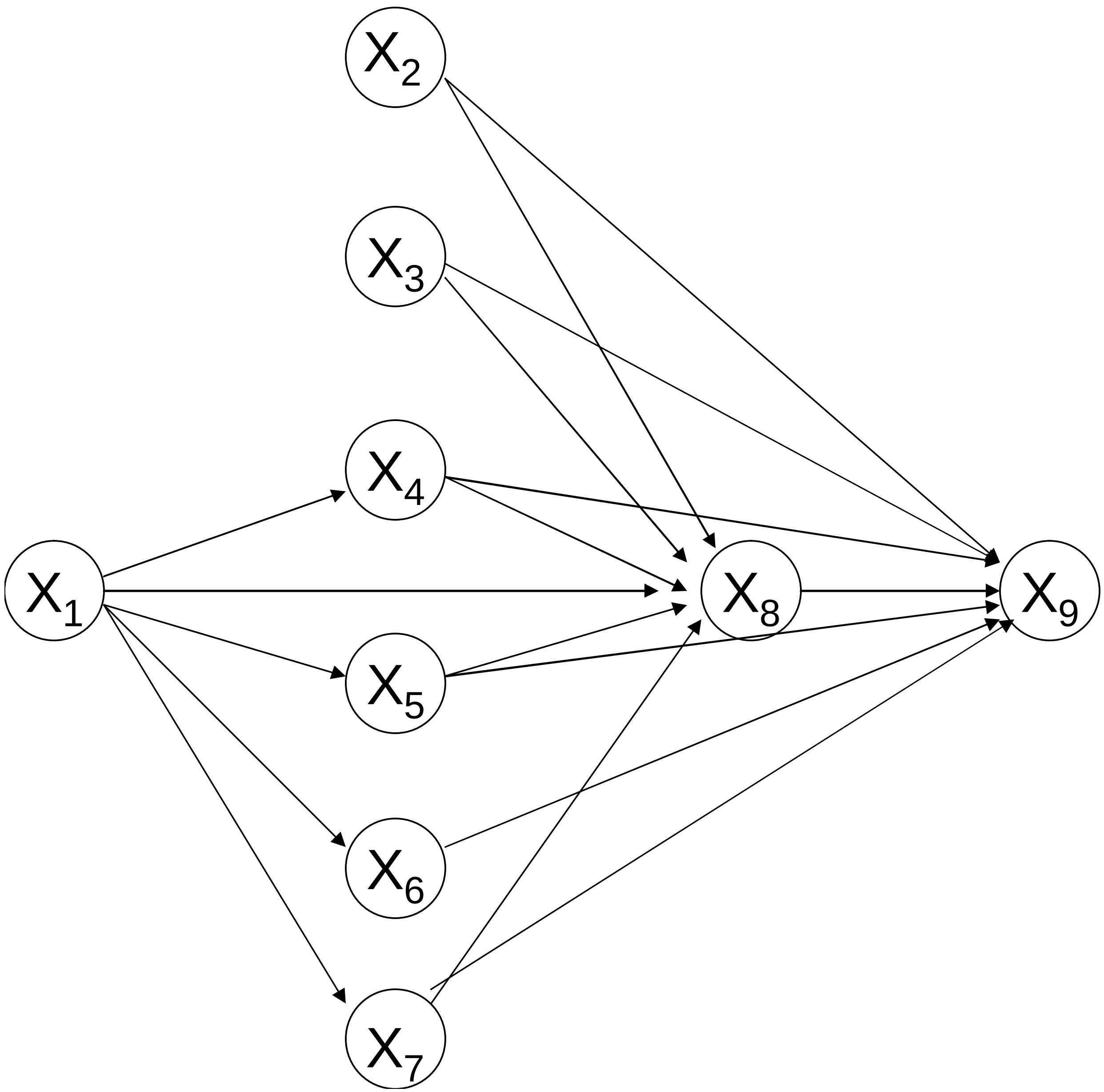

X_1 = Training
X_2 = Technology Maturity
X_3 = Team Composition
X_4 = Hrs Spent In Peer Review
X_5 = Type of Review
X_6 = Domain
X_7 = Development Env
X_8 = Peer Review Efficiency
X_9 = IV&V CPI/SPI

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- We could be doing a much better job and adding more value to our level 4-5 processes by incorporating the use of the scientific method and inferential statistical models into our measurement and analysis processes
- The data is there, but being collected inconsistently
- Random samples allow us to create probability distributions, generate sample statistics and to test null hypotheses that will aid us in being able to predict the effect of fine tuning our methods used to build our products and Dispel myths and non truths regarding the value of non-value added tasks.
- Statistically significant results typically warrant further investigation
- Correlation is not necessarily causation

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Creating Process Performance Models

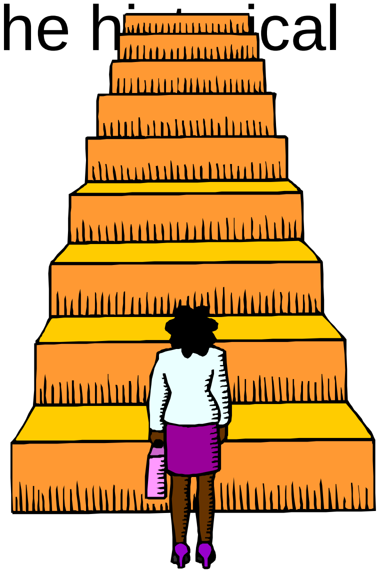
A Customer Services Example

Virginia Slavin
Systems and Software Consortium, Inc

SOLUTIONS TOGETHER

A FEW SIMPLE STEPS

1. Determine what you are trying to accomplish!
2. Identify the activities involved in accomplishing the objective.
3. Understand how much the activities impact the outcome.
4. Gain a statistical understanding of the historical performance of key activities.
5. Do the math.
6. Model the objective.
7. Use the model.
8. Rinse and repeat.

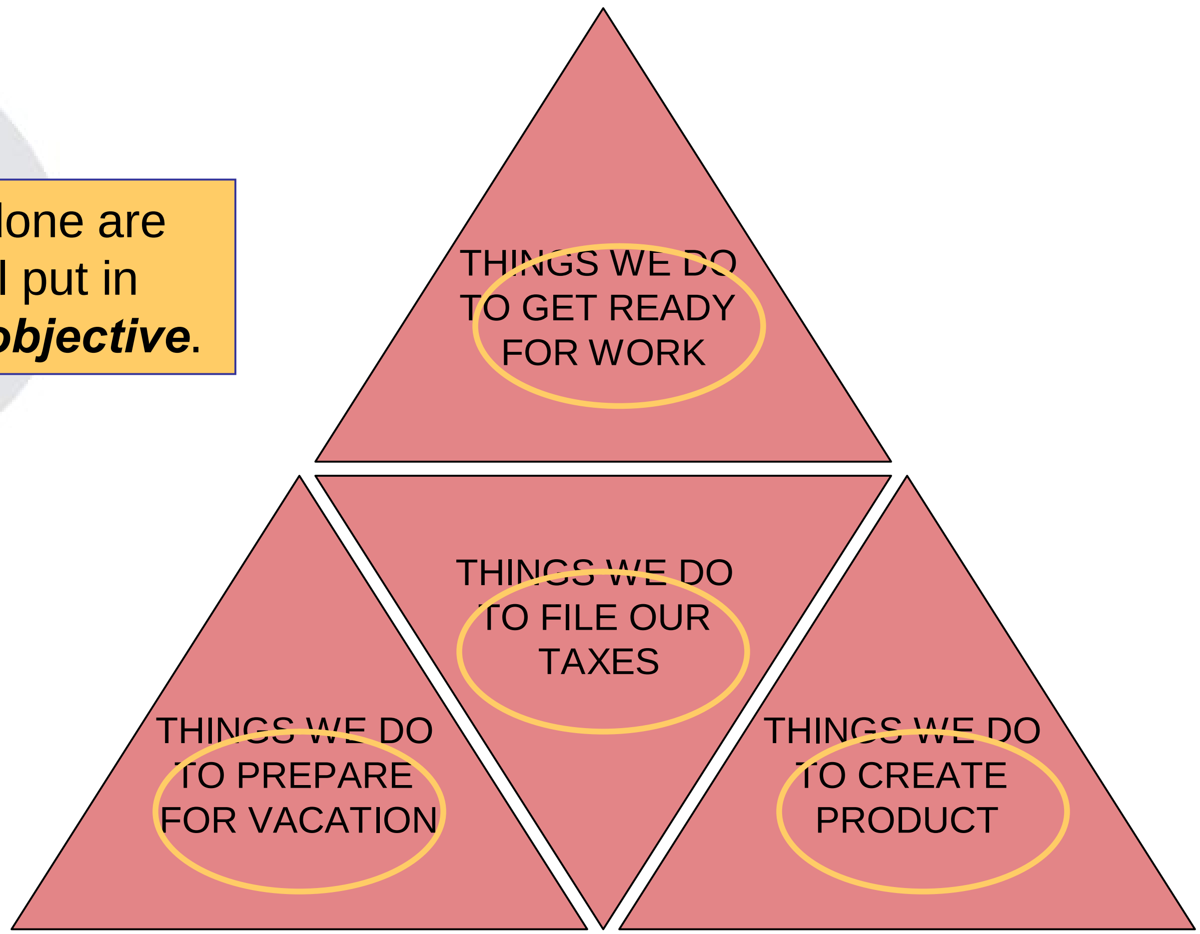


SOLUTIONS TOGETHER

Definitions (my version)

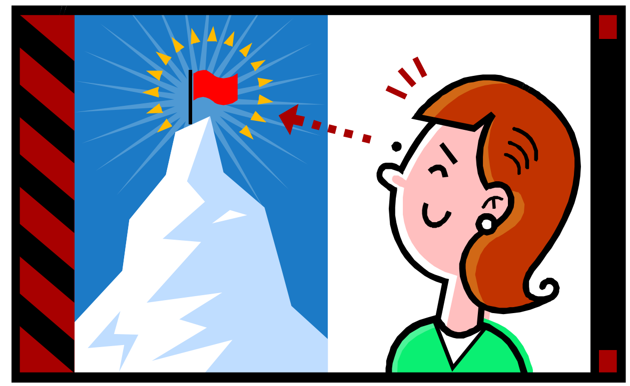
Å Objective ï something you are trying to accomplish

The things being done are meaningless until put in the ***context of the objective***.



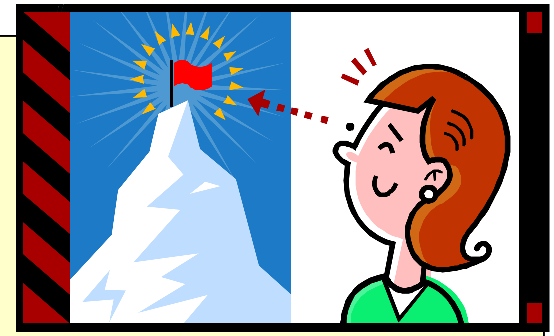
STEP NUMBER 1

- Determine what you are trying to accomplish!
  - What is the objective?



SOLUTIONS TOGETHER

STEP NUMBER 1



Company XYZ

Increase Sales in Customer Service area by selling more features to existing customers.

Why aren't they already doing this?
NO TIME!!!

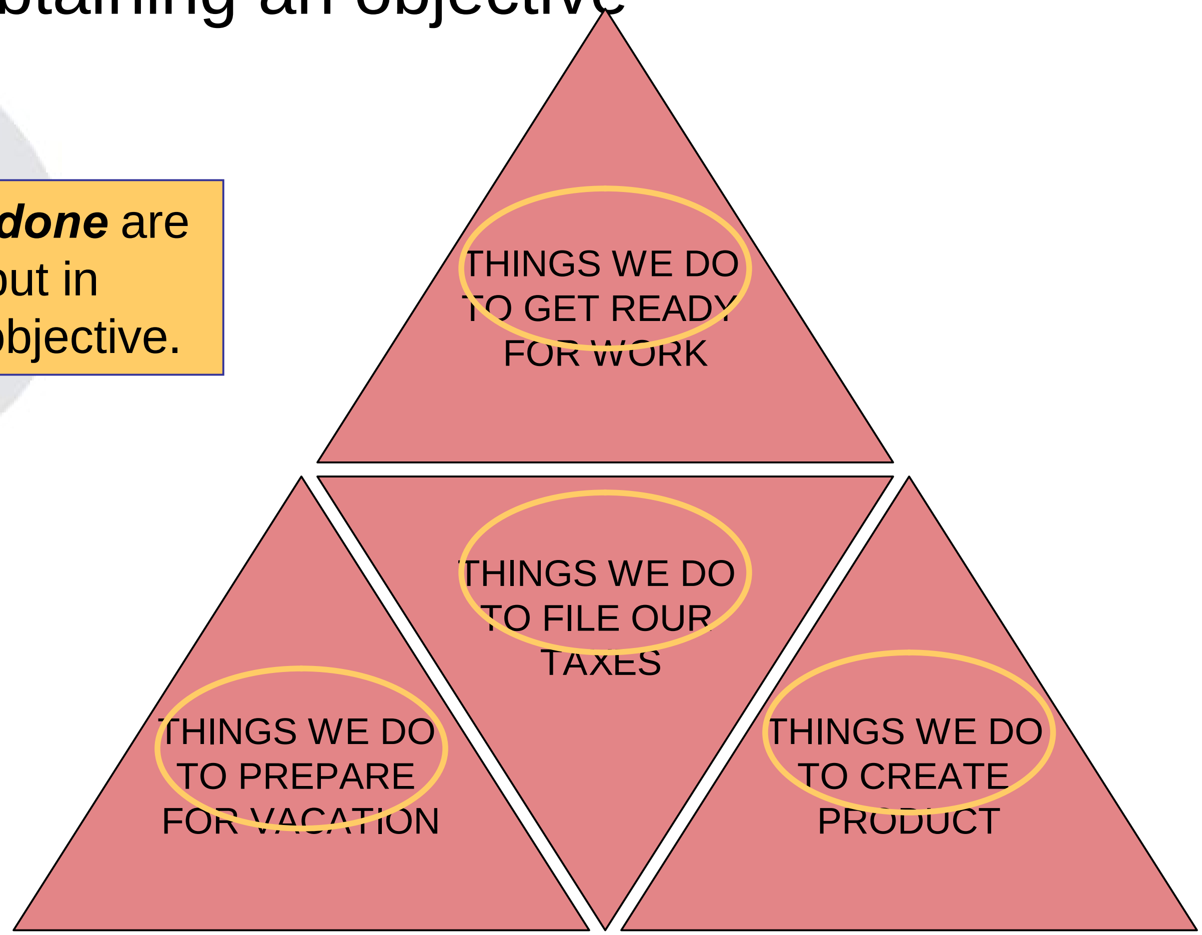
Refined Objective: Create more time for customer service reps to have available for selling features to existing customers.

SOLUTIONS TOGETHER

Definitions (my version)

Å Sub-Process or process elements ï the activities involved in obtaining an objective

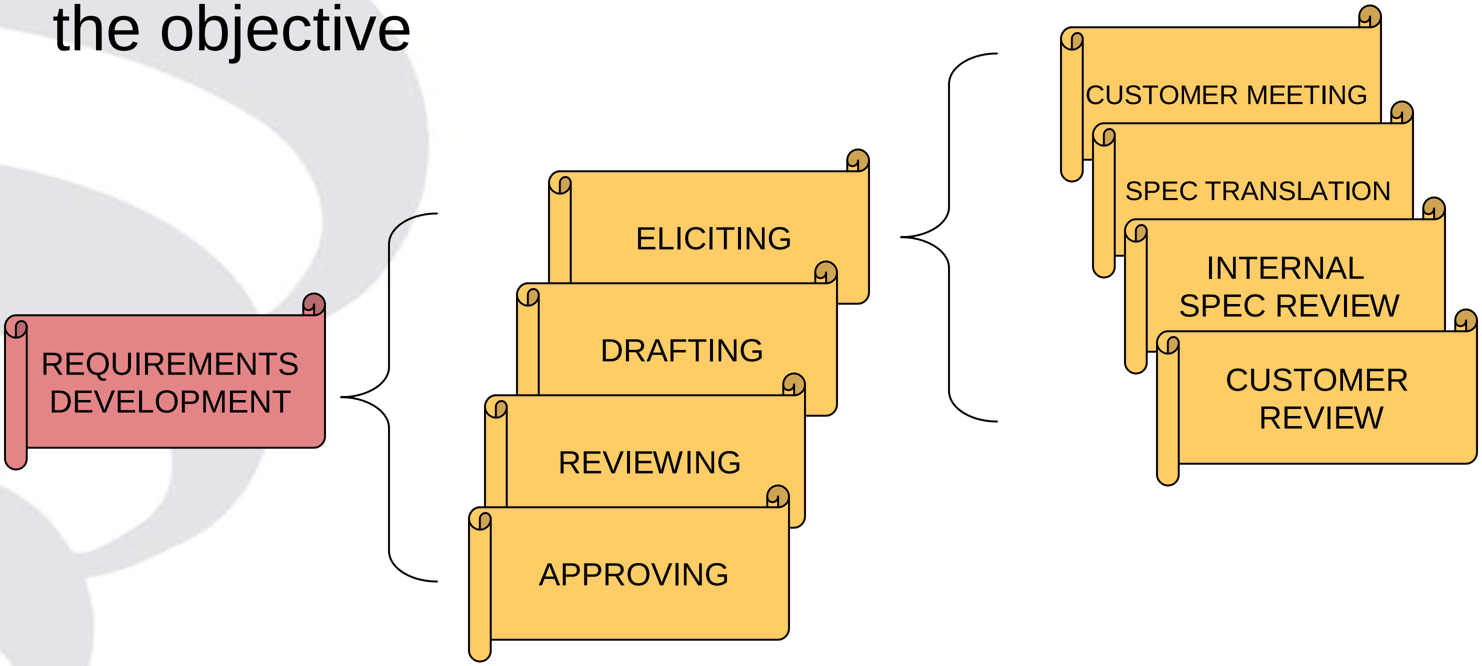
The ***things being done*** are meaningless until put in the context of the objective.



STEP NUMBER 2

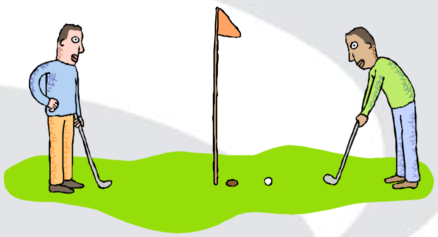
THINGS WE DO TOé

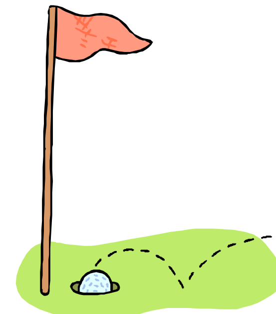
- Identify the *activities* involved in accomplishing the objective.
  - This could be an iterative step depending on the objective

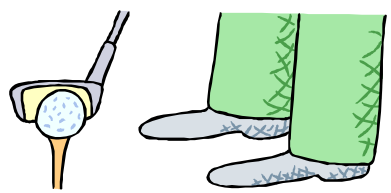


SOLUTIONS TOGETHER

Insert Metaphor Here







SOLUTIONS TOGETHER

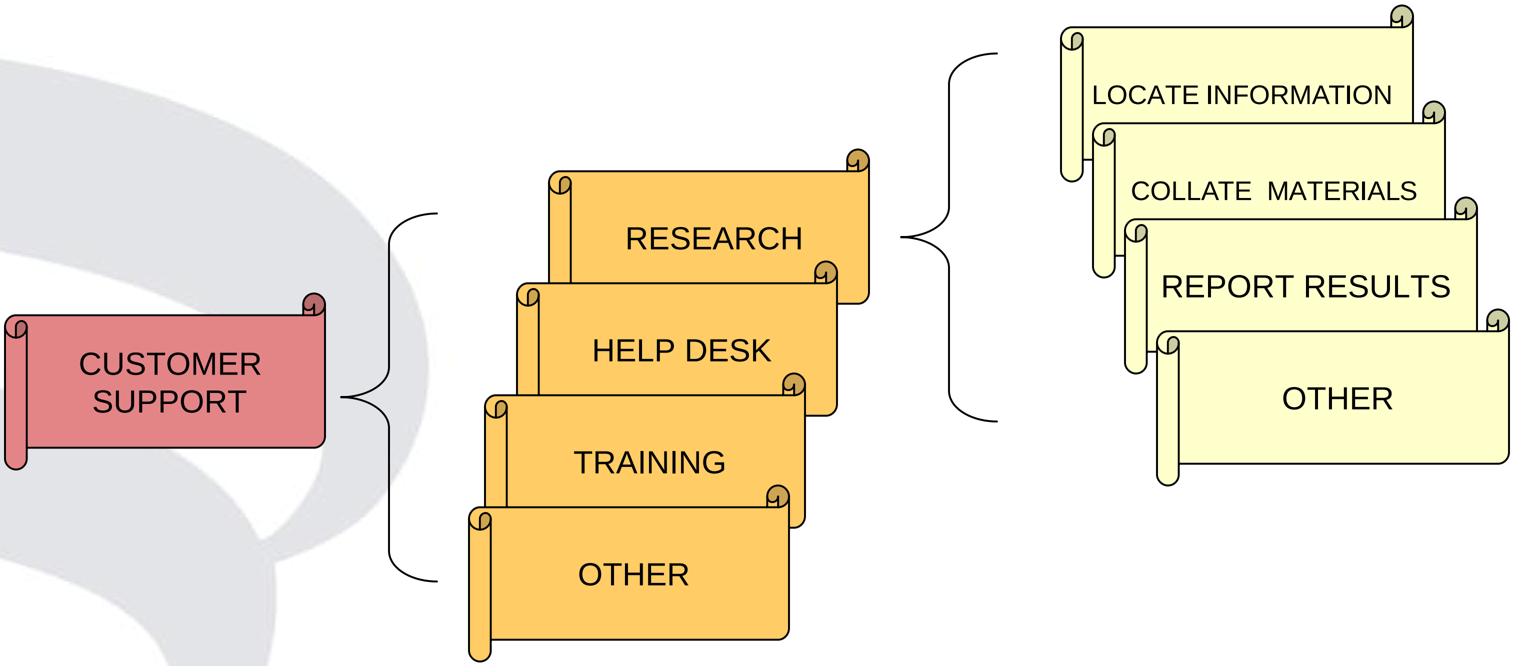
Tricks to Step 2

Break the activities down to something that can be *controlled*

- *Attendance*
- *Amount of material*
- *Amount of time*
- *Etc.*

SOLUTIONS TOGETHER

STEP NUMBER 2 Example

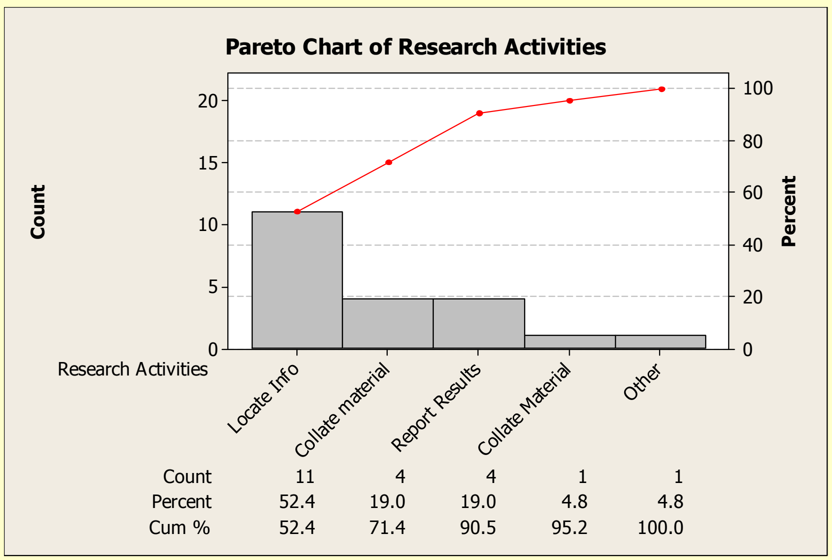


STEP NUMBER 3

- Understand how much the *activities* impact the *outcome*
  - Many statistical techniques available to ascertain this, if necessary
    - ANOVA, Correlation, hypothesis testing, etc.

Company XYZ

How much time is being spent in each of these Research Activities?



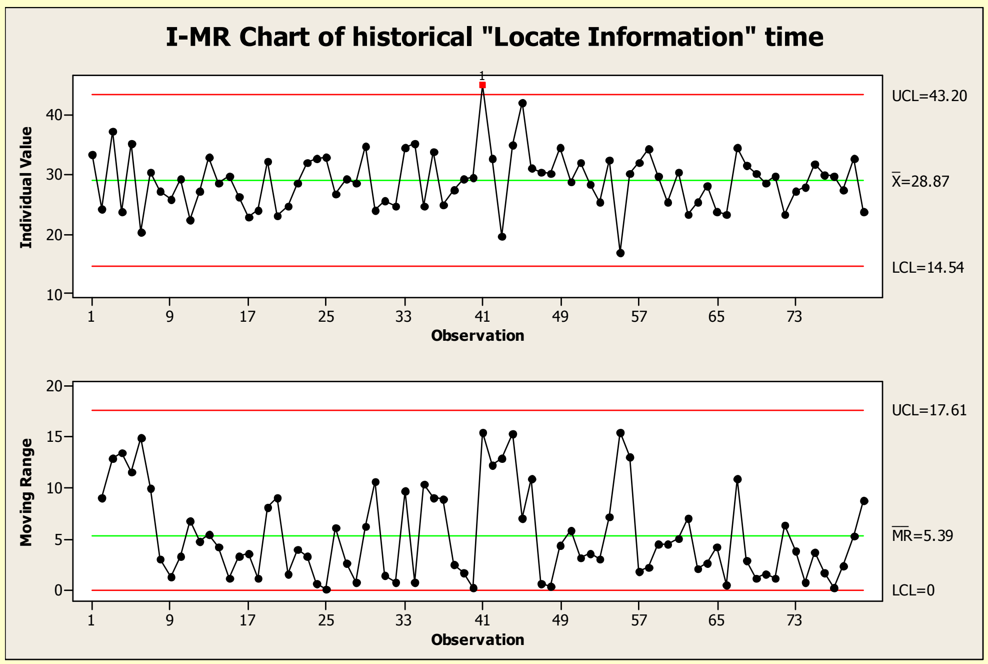
May want to use sampling techniques for initial data

SOLUTIONS TOGETHER

STEP NUMBER 4

- Gain a statistical understanding of the *historical* performance of key activities
  - Typically use Control Charts for this, or some type of historical

Company XYZ historical results



SOLUTIONS TOGETHER

STEP NUMBER 5

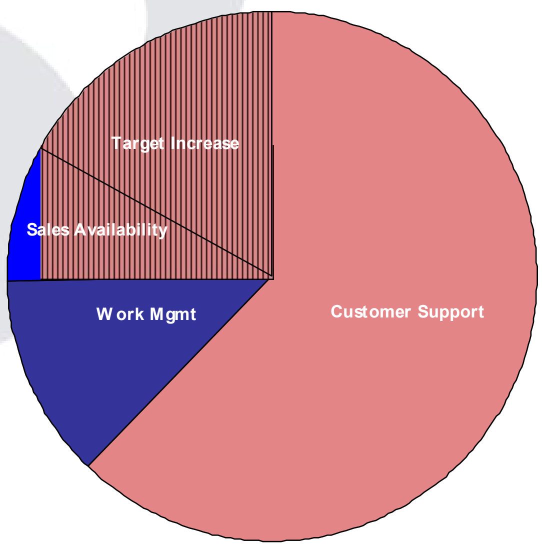
Å Do the Math!

ï Locate Information = 52.4% of Research Time

ï Total Research Time = 65% of Customer Support Time

ï Need to Increase available time by 15%

ï Total CS Hours currently are 5500



Cut ñLocate Informationò time by 535 hours

SOLUTIONS TOGETHER

STEP NUMBER 6

- Model the Objective!
  - May need to include multiple activities and process areas to put together the best picture for meeting the objective.
  - At this point we are really trying to understand how changes to the process activities impact the objective or target

Company XYZ

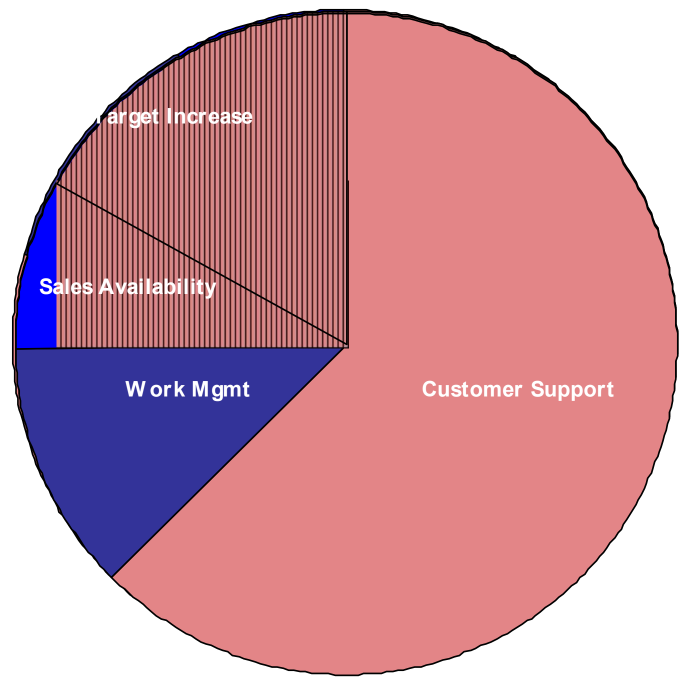
How do we define Sales Availability as a function of "Locate Information"?

SOLUTIONS TOGETHER

STEP NUMBER 6 Example

If it takes on average:

- 29 hours to locate info
- 30 hours to locate info
- 25 hours to locate info
- 20 hours to locate info



SOLUTIONS TOGETHER

USING THE MODELS

Å Understand ***quantitatively*** what needs to change, if anything, in order to reach the objective

ï How much, exactly, do we need to change? (from 29 to 20 hrs to ñlocate informationòï sets the specification)

ï Maintain a statistical understanding of the ***current*** performance of key activities

ï The best way to ensure you will not exceed spec is to monitor average and variation in control chart

Å Monitor the execution of the process activities in order to ensure consistent execution

Å Regularly input process activity values into model equation to ascertain current status to objective

RINSE AND REPEAT!

Å Be aware
- ï No model will be ñaccurateò the first time through, but it will still provide information
- ï A few iterations must occur before you will adequately understand relationships between process activities and objectives
- ï Continue monitoring process activities in order to ensure consistency of execution
- ï The more unstable your process execution, the less predictable your model will be

SOLUTIONS TOGETHER

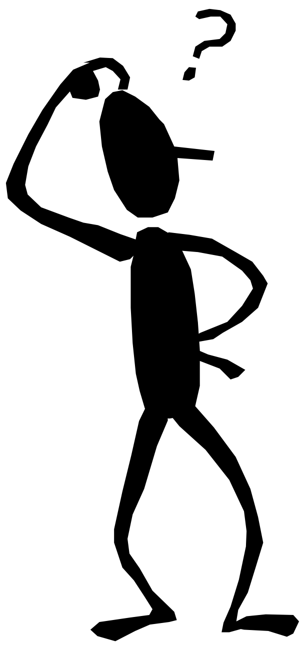
OTHER EXAMPLES OF PROCESS PERFORMANCE MODELS

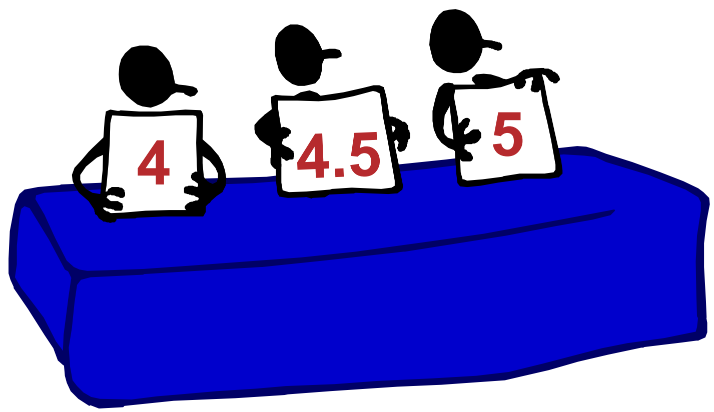
- Post release defects as a function of amount of material inspected
- Schedule impacts as a function of customer attendance at requirements reviews
- Cycle time as a function of reused components
- Rework budget as a function of design inspection prep time

- ***YOUR MODEL WILL VARY!!!***

SOLUTIONS TOGETHER

Questions or Comments?





SOLUTIONS TOGETHER

For More Information

- Technical questions:
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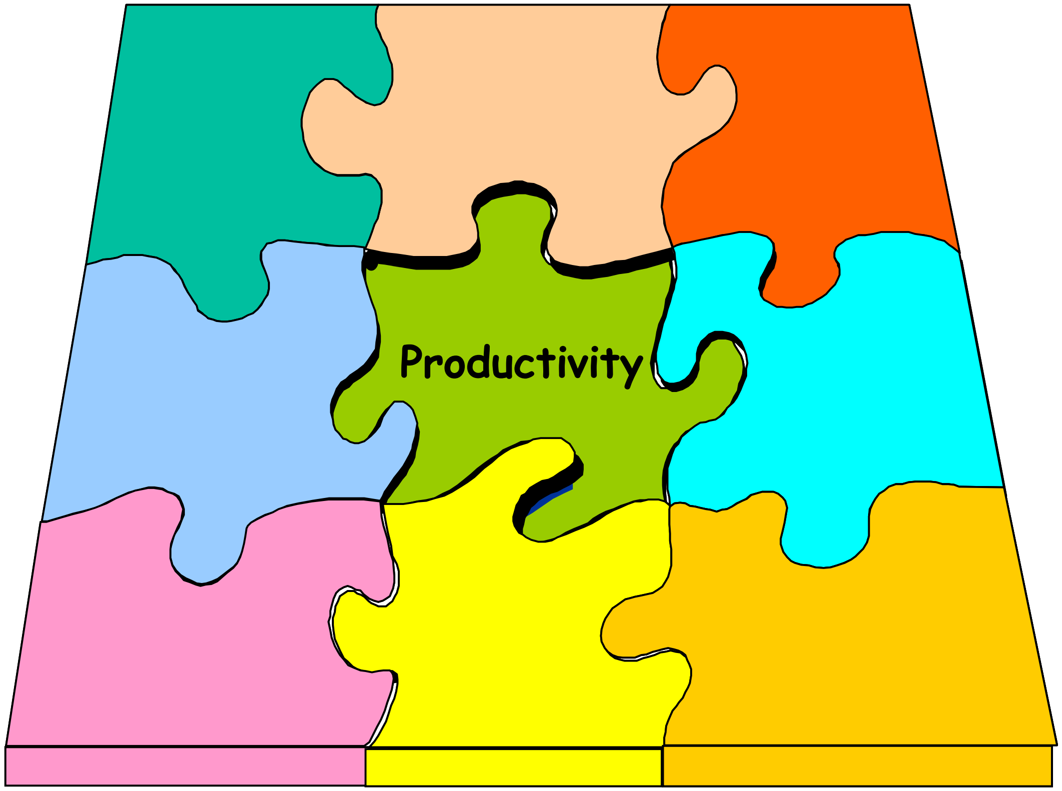
  - slavin@systemsandsoftware.org
- For services, training requests, account information:
  - Hillary Davidson, 703-742-7188
  - davidson@systemsandsoftware.org
- For Consortium products or general questions:
  - Contact Clearinghouse (ask-spc@software.org)
  - or 800-827-4772
- If you are a Consortium member, go to www.software.org and select For Members Only to download documents or view product websites (will automatically get you on newsletter mailing list)

Raytheon
Customer Success Is Our Mission

The Productivity Puzzle

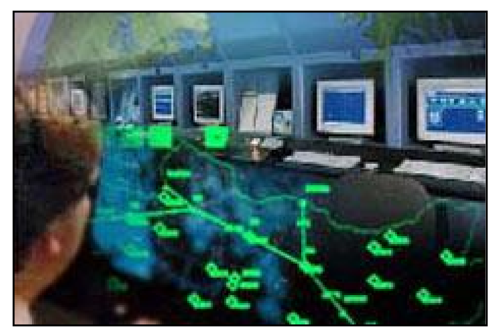
- Introduction to Raytheon
- Introduction to Productivity
- Pieces of the Puzzle
- The Puzzling Issues
- Q & A



Raytheon

Raytheon and NCS

- Raytheon is an industry leader in defense and government electronics, space, information technology, and technical services
- Network Centric Systems (NCS) develops and produces mission solutions for networking, command and control, battle space awareness, homeland security and air traffic management



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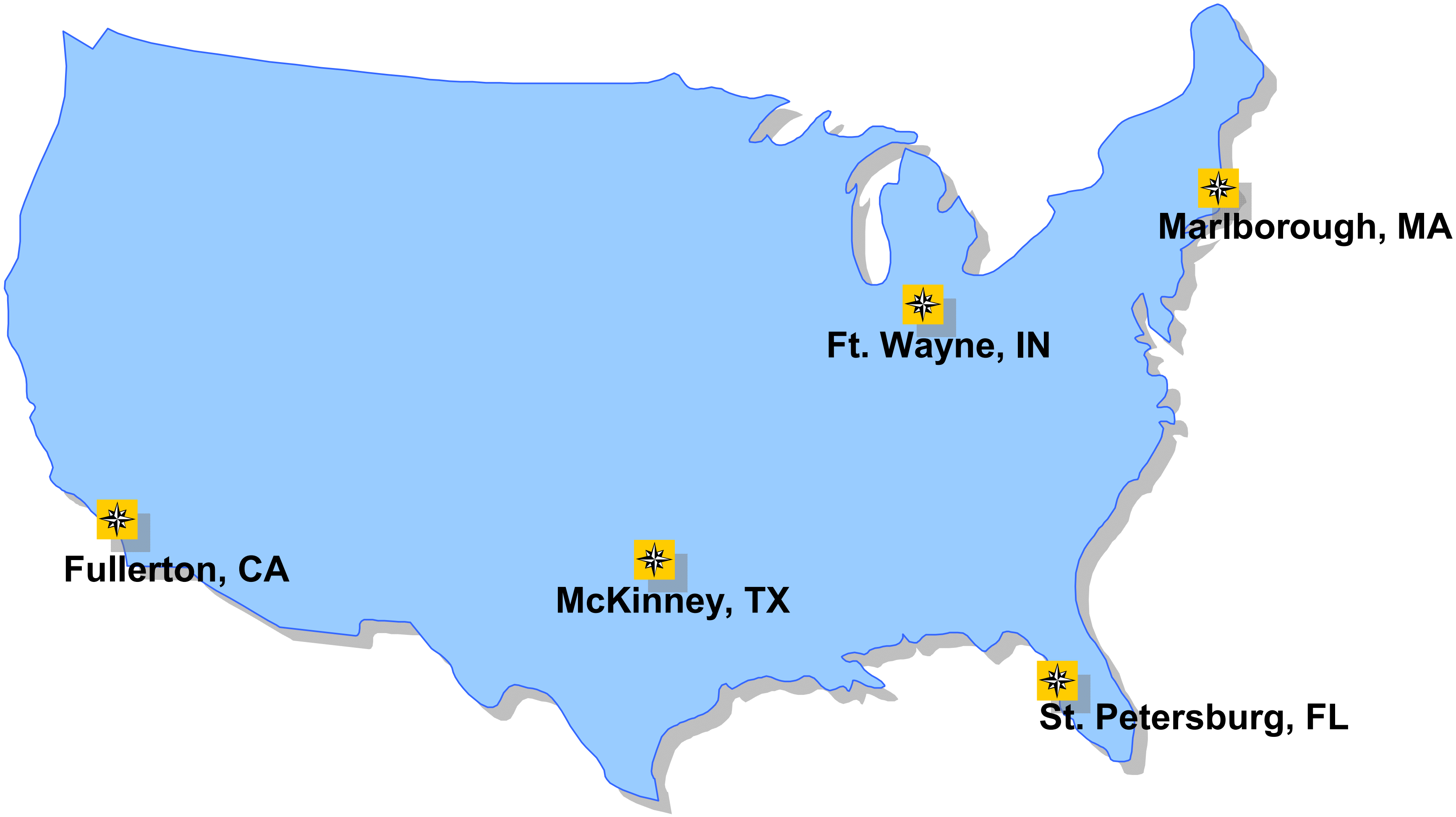


Å NCS Engineering Organization = Over 5,000 individuals

Å Appraised as CMMI Level 5 for Systems, Hardware and Software Engineering is June, 2007

Productivity

- Per Webster.com, productivity is:

Main Entry:

ï **pro·duc·tiv·i·ty**

Pronunciation:

ï **\□prō-dək-□ti-və-tē, □prä-, prə-□dək-**

Function:

ï *noun*

Date:

ï circa 1810

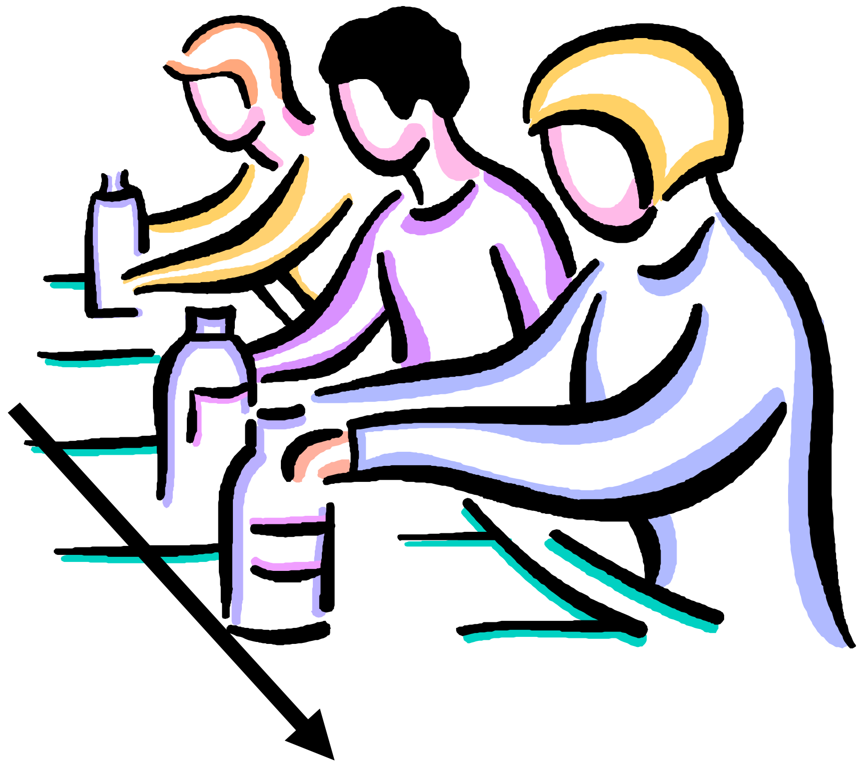
1 : the quality or state of being **productive**

2 : the rate per unit area or per unit volume at which biomass consumable as food by other organisms is made by **producers**

Raytheon

Productivity (continued)

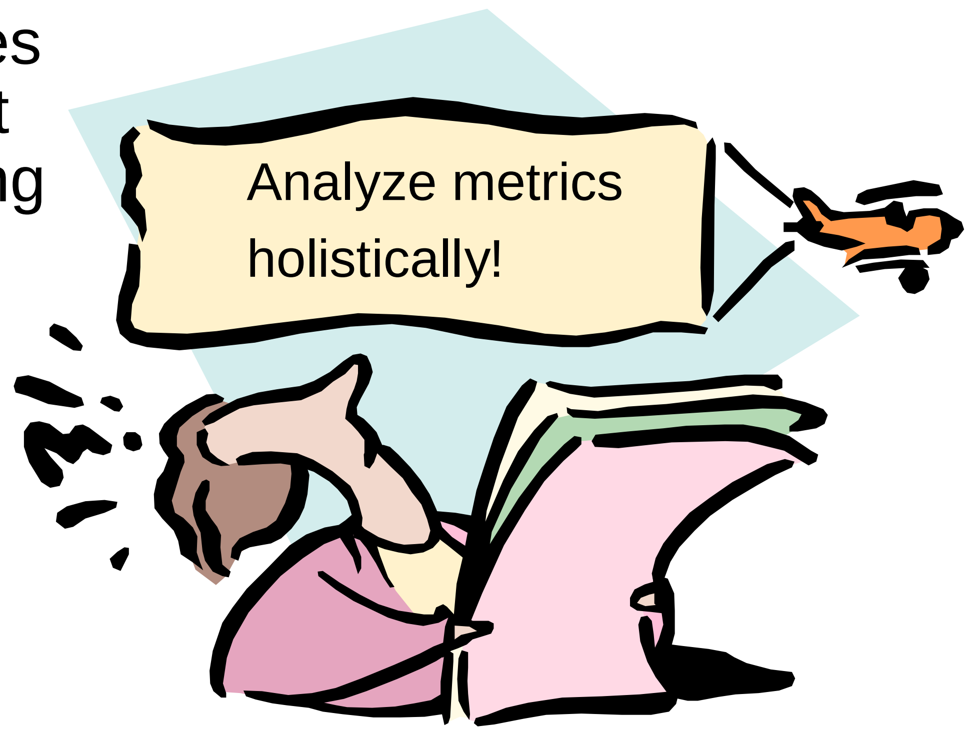
- In the manufacturing world, productivity is number of widgets created per time
- Use productivity as input for estimation and planning: If we know we can produce X widgets / hour, and we have an order for 100X widgets, then it will take us 100 hours to meet the order



Raytheon

Productivity (continued)

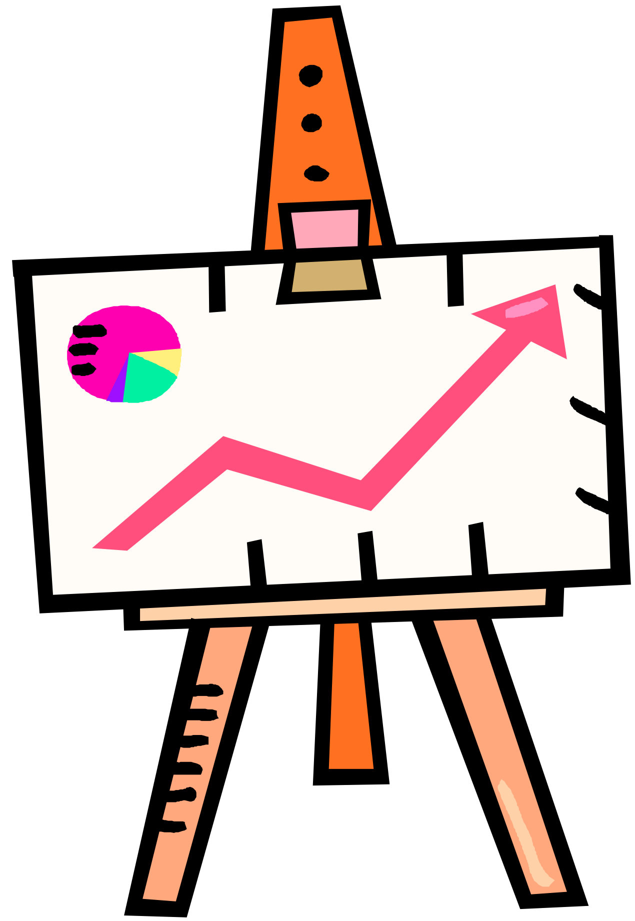
- Also use productivity to aide with analysis regarding program progress, if CPI (Cost Performance Index) and SPI (Schedule Performance Index) appear to be good, the program could still have issues if productivity is not near what was originally planned. Rolling up measurements can mask issues



Productivity (continued)

- Increased productivity can be used as a measure of process improvement, if all else is held constant

- Letôs look at an exampleé .



Productivity (continued)

- In the Olympic sprint events, the distance is the ñsizeò that is producedð so the 200 meter dash is twice as far as the 100 meter race

- Productivity is measured as size per time such as meters / second

- If you change the size, the time will have to change, assuming that productivity remains constant (and it is fairly constant at the Olympic level)

Photos: Credit Getty Images

uzzle: roductivity

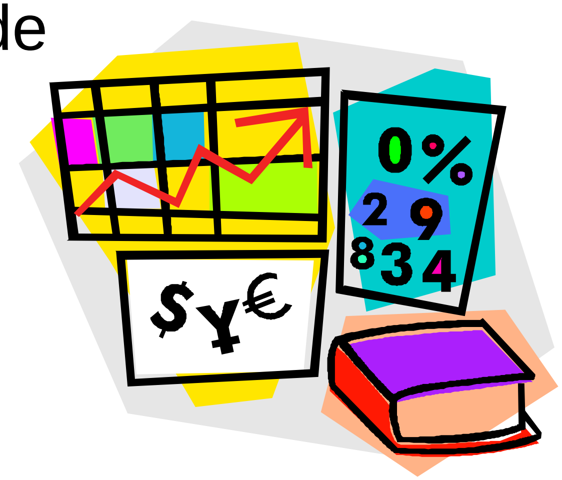
Raytheon

Productivity = Size / Hours

Size = ELOC = Equivalent Lines of Code

Hours = SW development hours

$= (ACWP_{CTD} + ETC)$



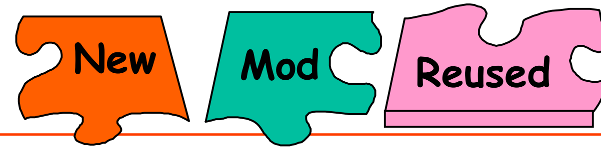
$ACWP_{CTD}$ = Actual Cost of Work Performed (cumulative to date)

ETC = Estimate to Complete

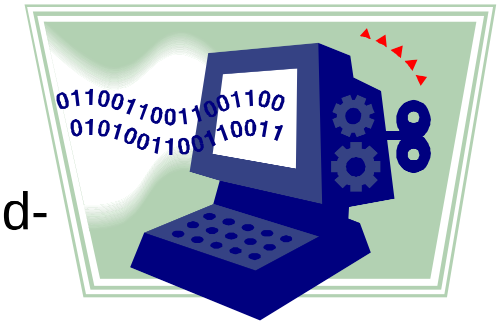
= the remaining hours expected to complete the work

Raytheon

uzzle: Size



Size data includes these counts, in lines of code, or thousands of lines of code, KSLOC

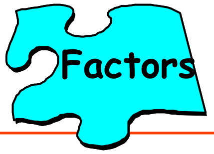


ï **New:** Any software or firmware unit that is to be newly developed or does not fit the reused or modified software definitions

ï **Reused:** If no lines of the actual component code are going to be changed. This includes comments. If the component is to be edited for any reason, it cannot be classified as reused. If the component is to be converted to a different language, it cannot be classified as reused

ï **Modified:** Estimated SLOC modifications for that component do not exceed 50% of the actual counted SLOC. If the SLOC modifications exceed 50% of the actual size, the effort associated with understanding and modifying the component is likely to be equal to or exceed the effort required to develop it new, so treat it as new

uzzle: Size (cont.)



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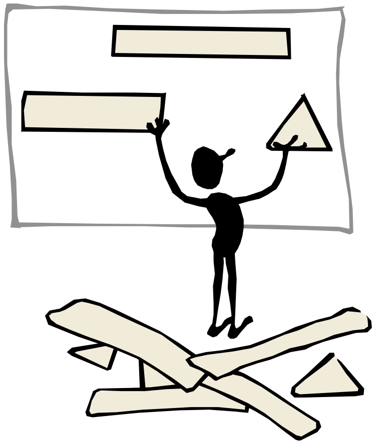
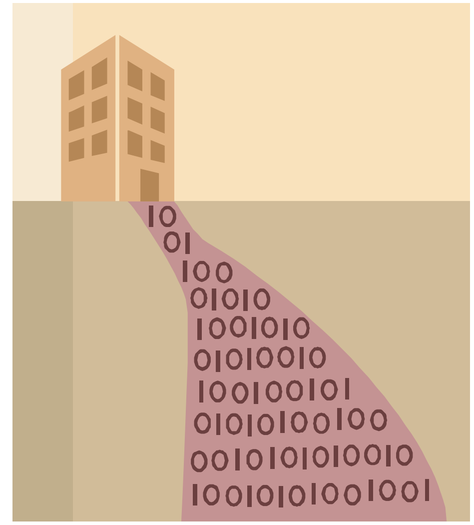
Size data includes these factors:

- **Reuse Factor (F_R):** F_R is the factor for converting reused code (SLOC to ELOC). It represents the percent of overall effort that the estimator believes will be required to adapt the existing software component and artifacts, versus developing the software and all associated artifacts from scratch
- **Modified Factor (F_M)**: F_M is the factor for converting modified code (SLOC to ELOC). It represents the percent of overall effort that the estimator believes will be required to adapt the existing software component and artifacts, versus developing the software and all associated artifacts from scratch



uzzle: Size (cont.)

- Delivered Lines of Code:

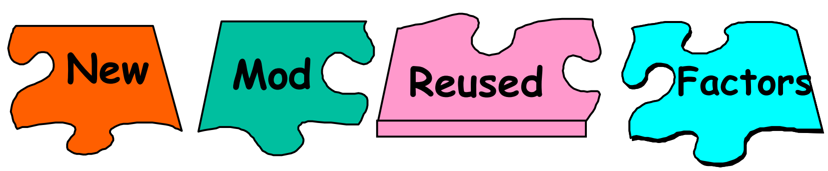


DLOC = New + Reused + Modified

- Equivalent Lines of Code:

ELOC = New + (Modified *F_M) + (Reused * F_R)

ELOC is generally used for productivity as it results in a more representative measure



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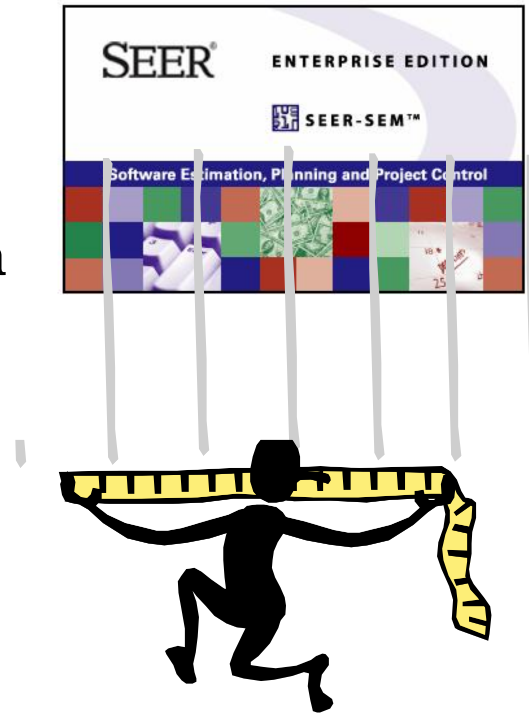
uzzle: Size (cont.)

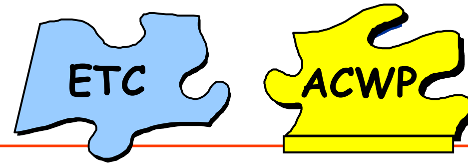
- You canôt attribute an increase in productivity to reuse
- Reuse/modification means that there is less work to do or, going back to the Olympic Sprint analogy, less distance to cover
- The productivity equation takes this into account using the Reuse and Modified factors

uzzle: Size (cont.)

- Raytheon has used parametric SW models such as COCOMO, COCOMO II, REVIC, Price-S, and SEER-SEM for many years
- Specific alignment was made to the SEER-SEM SW Application types to allow stratification of data such as productivity
- NCS SW Size measures support these models with parameters of Source Lines of Code (SLOC) categorized by Reused, Modified, and New, with Reuse and Modified Factors
- A standard NCS software line counting tool was deployed across all sites so that sizes are measured consistently and with automation
- Also aligned with customer expectations ï they often use these models



uzzle: Hours



SW Development Productivity Stages

Rqmts & Arch. Devel.	Prelim. Design	Detailed Design	Implementation	Integration	Verification & Validation	Production	Ops. & Support

$ACWP_{CTD}$ = Actual Cost of Work Performed (cumulative to date) = sum of all hours charged against SW Development Productivity Stages

ETC = Estimate to Complete = the remaining hours expected to complete the work

Specific cost collection codes are used to capture hours for Productivity measures

Raytheon

uzzle: Hours (cont.)

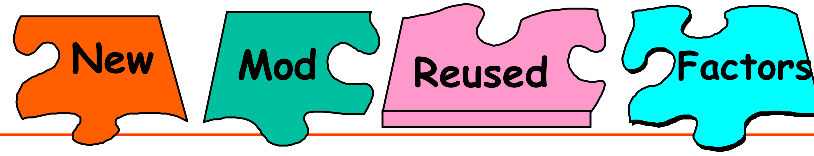
ACTIVITY TITLE	PE	SE	SW	HW: General Hardware	HW: Analog	HW: Digital	HW: FPGA	HW: Mechanical
PROJECT PLANNING & MANAGEMENT								
Planning and Management								
Quality Engineering								
Configuration Management								
REQUIREMENTS DEVELOPMENT								
System Requirements Definition								
System Design & Architecture								
Product Requirements Definition								
Product Design & Architecture								
Component Requirements Definition								
PRODUCT DESIGN & DEVELOPMENT								
Requirements Management								
Simulation and Modeling								
Preliminary Design								
Detailed Design								
Implementation								
Integration								
SYSTEM INTEGRATION & VALIDATION								
Product Verification & Validation								
System Integration								
System Acceptance Test								
System Field Test								

These elements contribute to the denominator in the productivity equation

- Aligns disciplines and activities
- Used to identify and collect costs for Work Breakdown Structure (WBS) elements
- Scheme is aligned with Cost Estimation
- Facilitates collection of consistent historical data
- Defect data can also be collected in these bins

Clearly define the denominator (e.g. hours) in the productivity equation

…sues



- How to modification of existing code/reuse of code

Equivalent = New + (Modified * F_M) + (Reused * F_R)

- 50% or less modification threshold, or counted as new
- If many products are at 50% while other products are at 10%, won't this skew the data?
- No changes, used as is, or counted as modified/new
- Cost of integration, and verification/validation will vary from product to product
- If you adjust the factors to account for this, how do you ñround tripò the data to ensure that your estimates will improve? Too many variables, not enough equations? We can't really measure the factors

Raytheon

sues (cont.)

Properties Stages

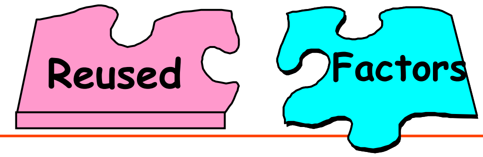
- How to measure productivity of non-traditional/partial lifecycles, such as modeling and simulation / demo products or maintenance versus mission software

SW Development Productivity Stages

Rqmts & Arch. Devel.	Prelim. Design	Detailed Design	Implemen-tation	Integration	Verification & Validation	Production	Ops. & Support

- May not fully execute all activities/stages
- Flag modified lifecycle, via properties, to allow stratification to avoid comparing ñapples and orangesò

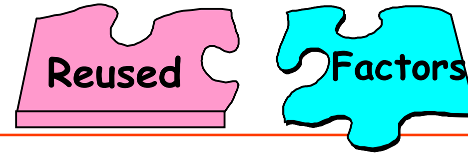
sues (cont.)



Raytheon

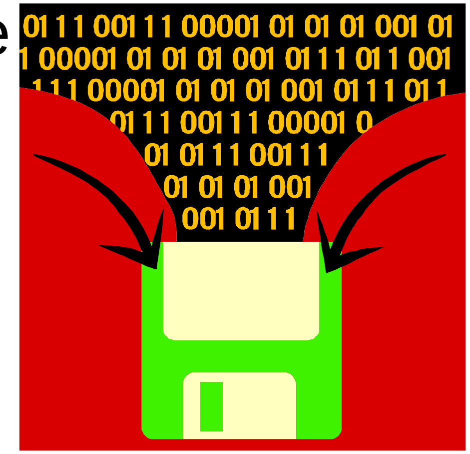
- How to handle inclusion of COTS
- When using COTS, there is no effort to create the code, but extensive effort can be spent on integration
- If the COTS code size is folded in with ñtraditionalòcode size, the productivity will be skewed
- One solution is to put this data into a separate ñbucketòso that it can be evaluated independently and then a factoring determined so that it can be rolled up
- Alternatively, COTS can be counted as Reused

sues (cont.)



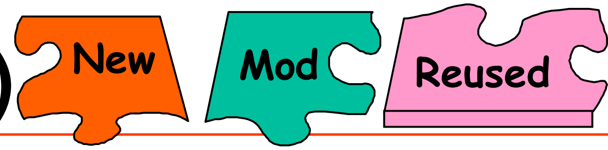
Raytheon

- How to handle inclusion of autogenerated code



- When using autogenerated code, the effort spent on creating the code itself is negligible
- If the autogen code size is folded in with ĩtraditionalòcode size, the productivity will be skewed
- One solution is to count the code as Reused with a low factor
- Alternatively put this data into a separate ĩbucketòso that it can be evaluated independently and then a factoring determined so that it can be rolled up

sues (cont.)



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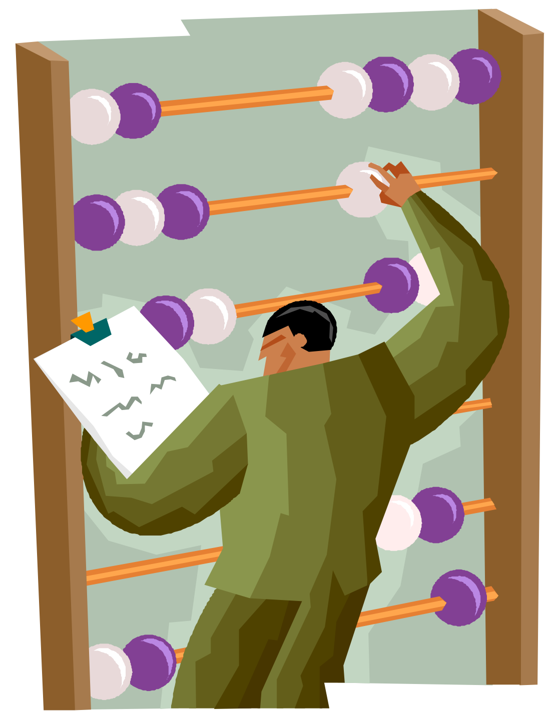
- Variation in measurement of size
- Not all using the same line counting tool
- Not measuring at the same level of granularity with regard to new/mod/reused
- Language impacts size
- Line counting tool evolutionð handling historical data
- Standardization/refine of organization tools/process on-going



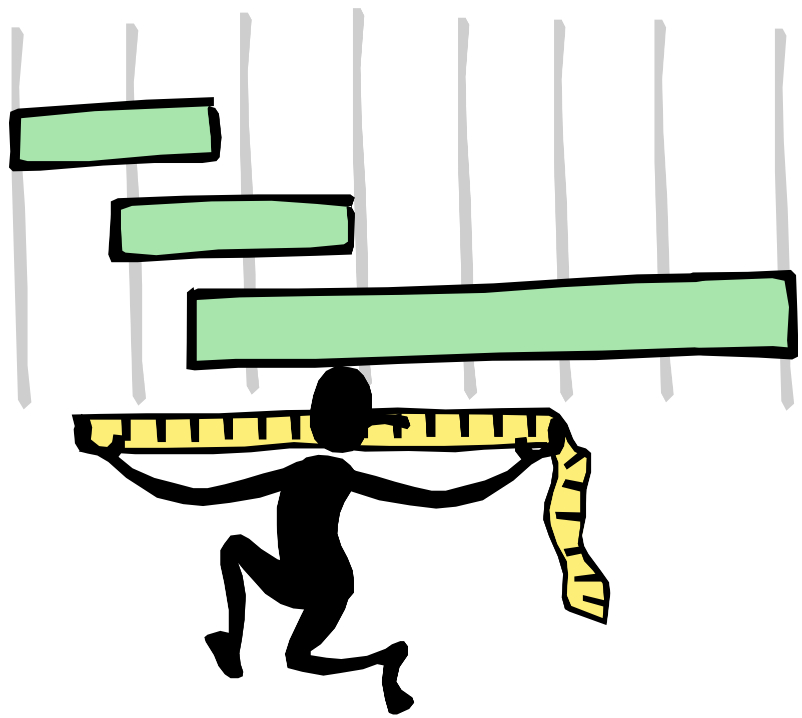
sues (cont.)

- Variation in measurement of hours
- Unpaid Overtime issue
- Supplier/Contractor labor → $ instead of hours
- Challenging issues due to financial policies / requirements / tooling

sues (cont.)

Raytheon

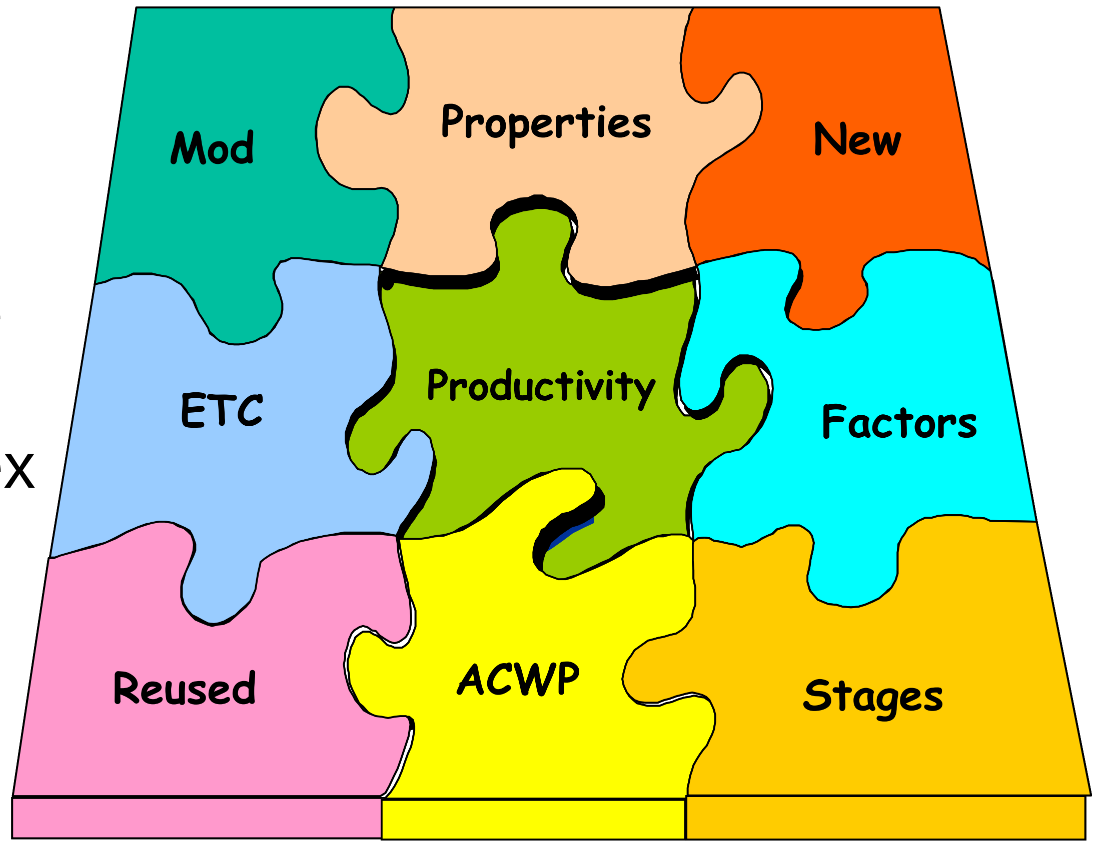
- Use of productivity during development vs. at program completionð projected vs actual
- Limited value during program
- Actuals used for planning and estimating



- Several factors contribute to the calculation of productivity

- Although the calculation of productivity is fairly simple, ensuring collection of appropriate data and the use of the measurement is complex

- Solving the puzzle of productivity is a continuing journey



QUESTIONS ?

Raytheon

ation

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Quantitative Software Management

Using Metrics to Develop a Software Project Strategy

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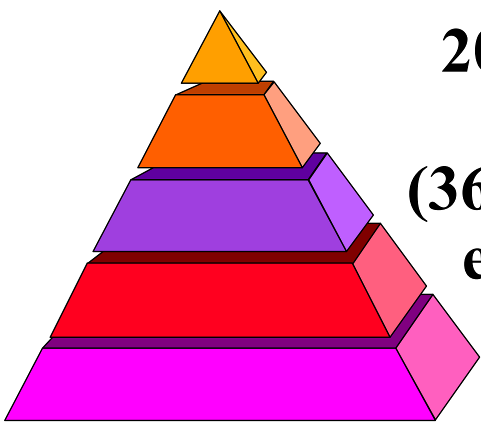
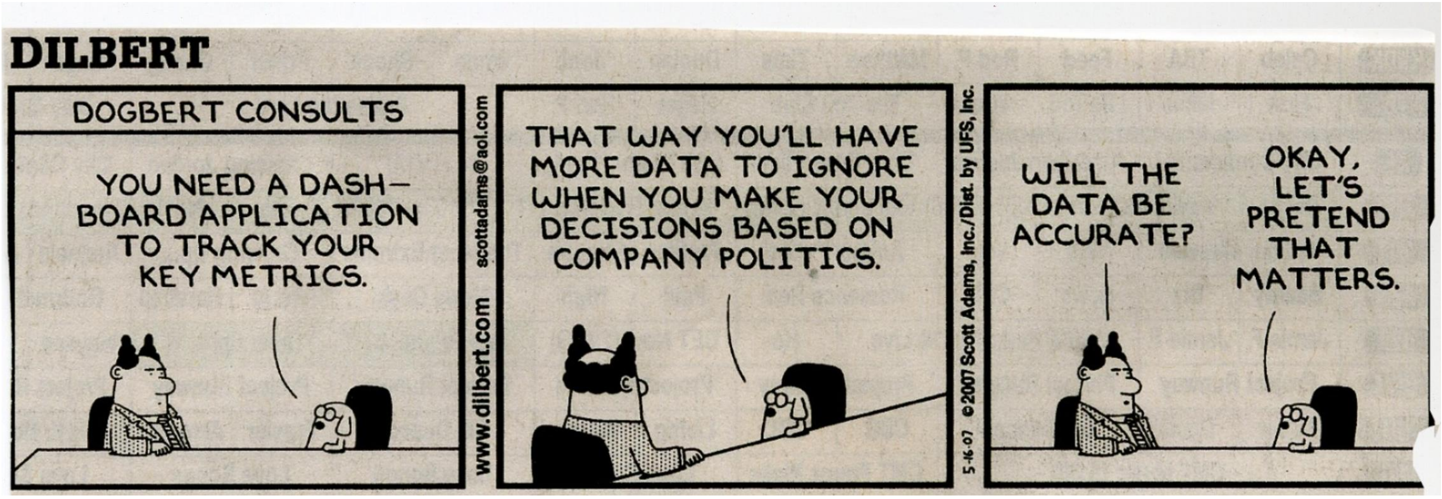


QSM The Intelligence behind Successful Software Projects

Outline

- Overview
- Measurement, Expense or Investment
- State of the Industry: Project Estimation
- Staffing and Schedule
- Understanding Trade-offs
- Conclusion
- Questions?

Overview



Does this sound familiar?

Measurement: Expense or Investment

- Software measurement (and process improvement) are viewed as <u>expenses</u>: Overhead
  - Lean, agile organizations want to reduce overhead
  - But, how do organizations become “lean & agile”?
- Part of cost of doing business
  - 3 – 5% on average
  - Project management averages 14%

Measurement: Expense or Investment

Å **What does software measurement provide?**

1. Knowledge of an organization's capabilities
2. Identifies patterns and trends (Strengths to leverage and weaknesses to correct)
3. Insight into projects in time to make effective mid-stream corrections
4. Ability to benchmark against competition or "the industry" in quality, productivity, and time to market
5. Quantitative basis for evaluating project and organizational performance

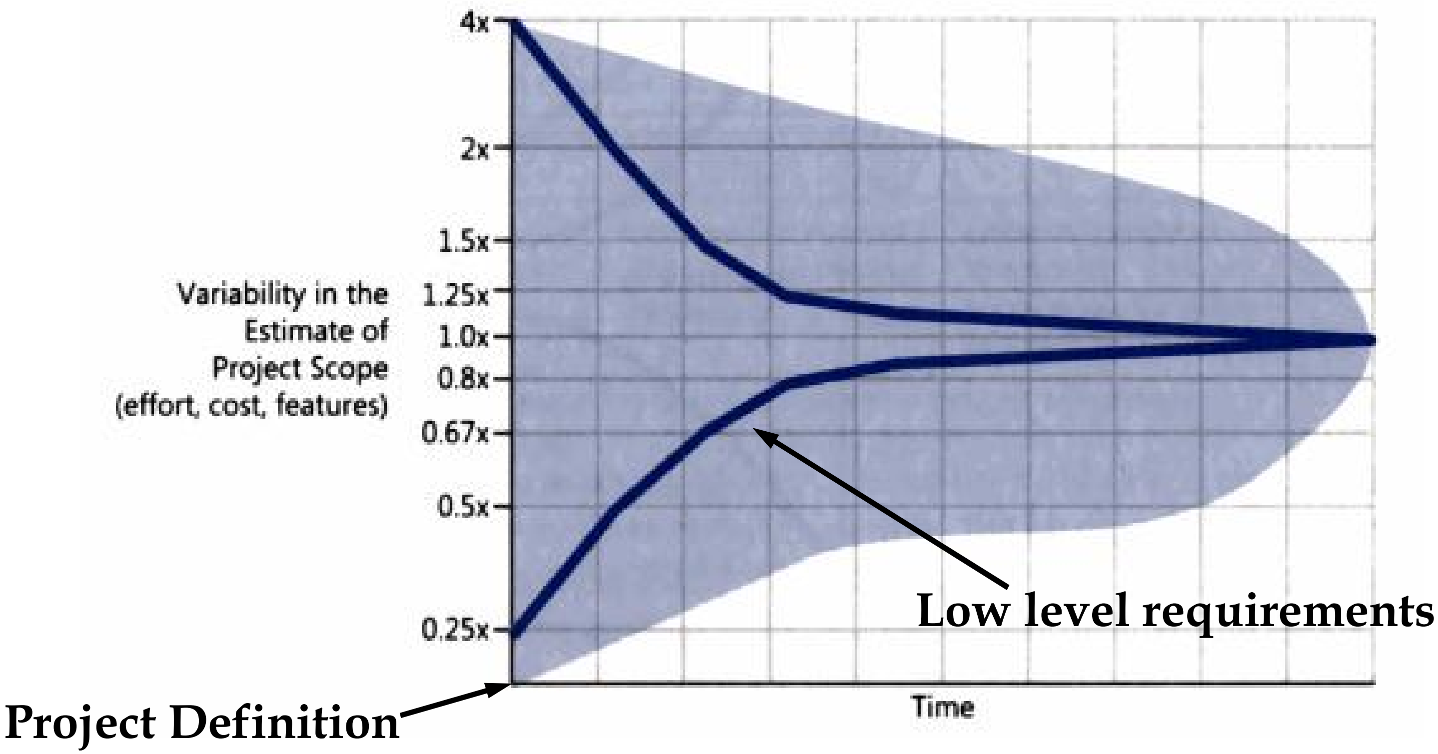
Å **Improves ability to meet commitments, avoid pitfalls, and evaluate trade-offs**

QSM The Intelligence behind Successful Software Projects

of the Industry: Project Estimation

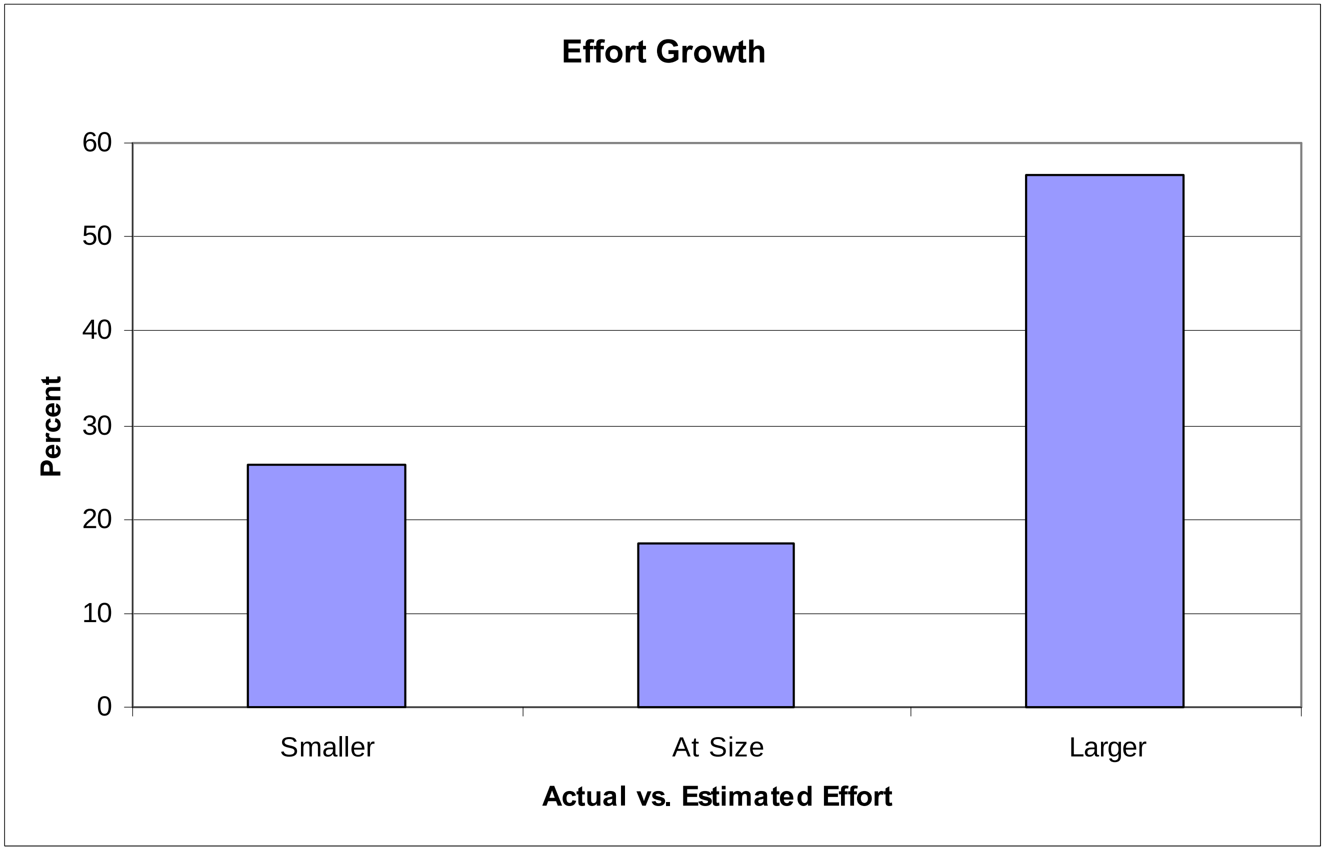
- Software estimates are not project plans
- Estimates contain uncertainty about two key components:
  - Scope of the requirements (project size)
  - Team productivity

The Cone of Uncertainty

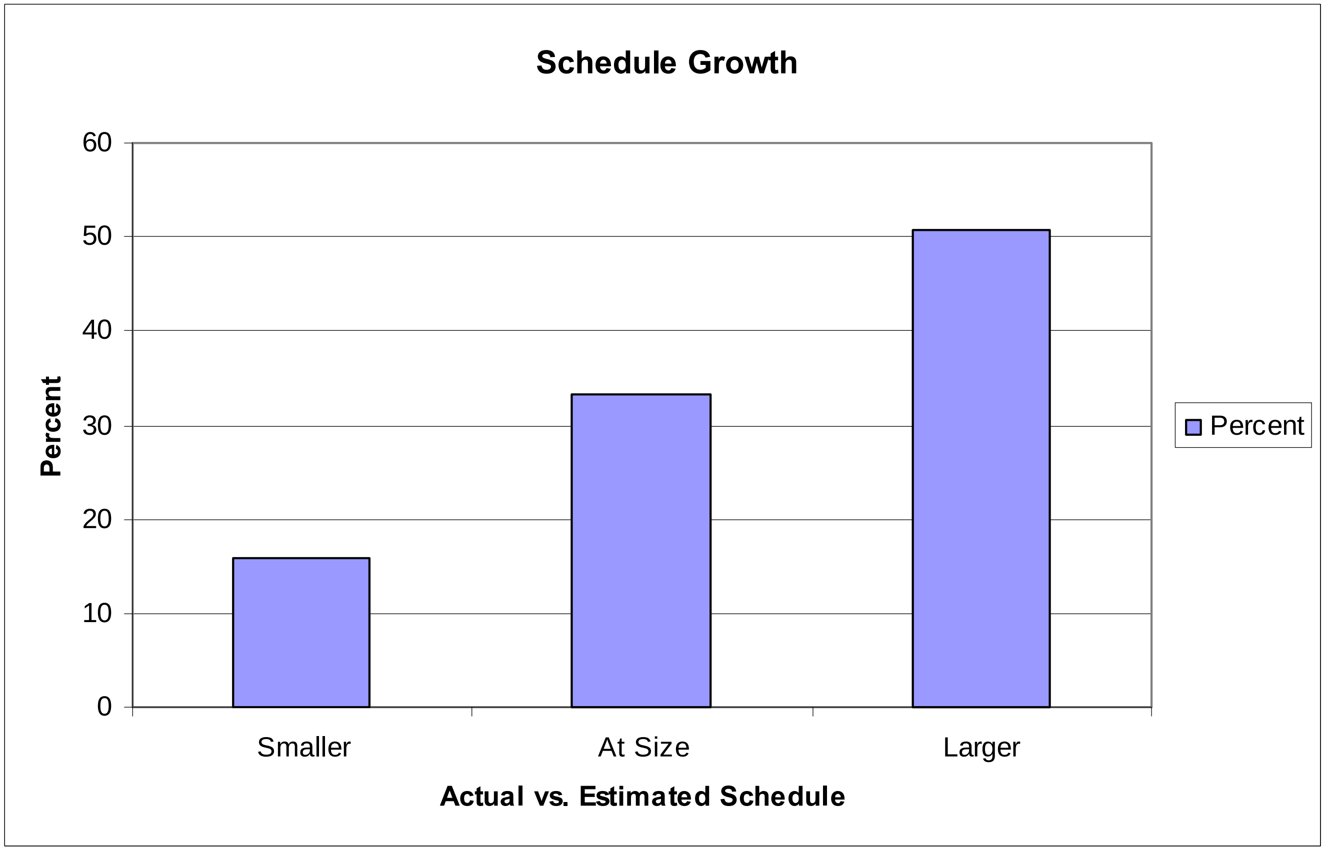


- Not enough information is available early in the development lifecycle to make accurate estimates
- Precision is not accuracy

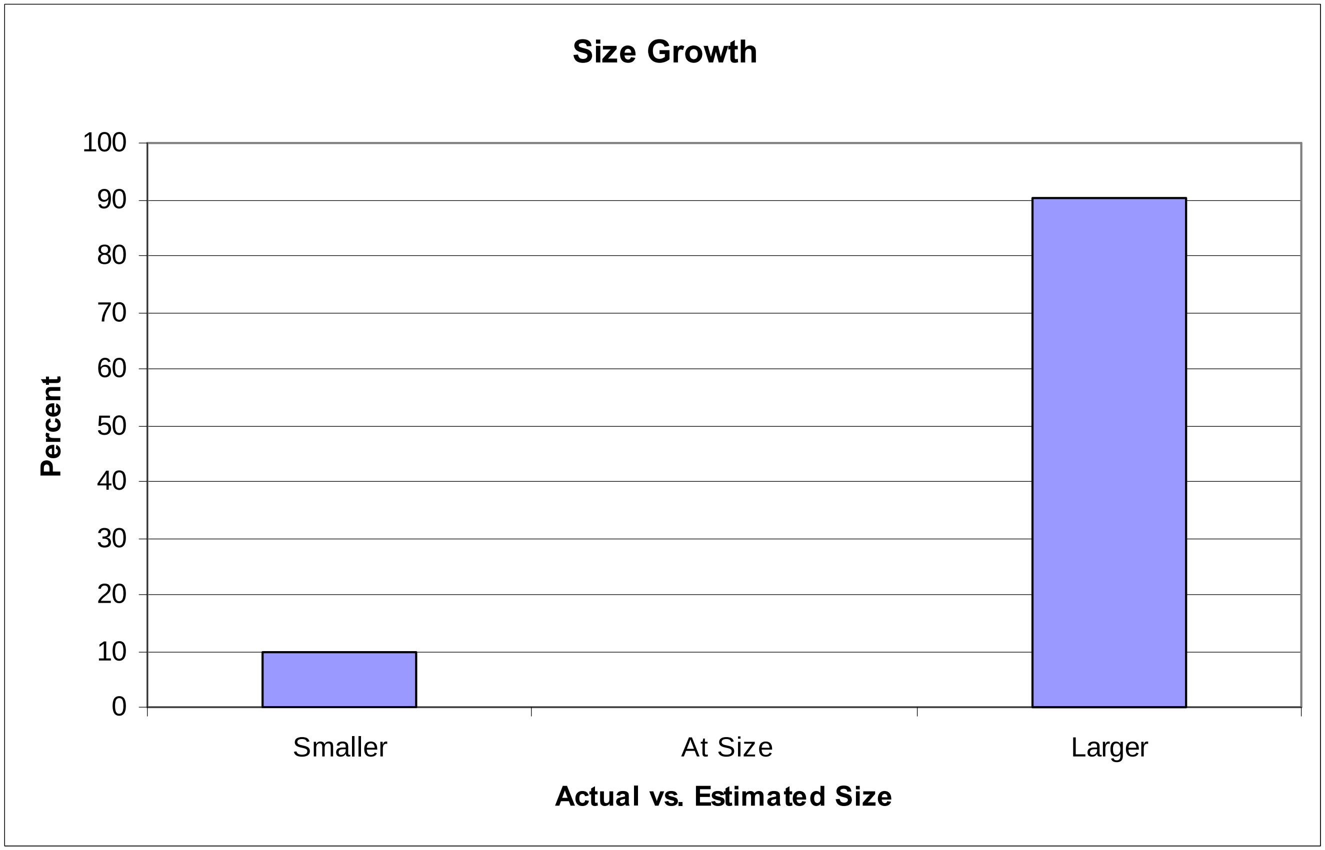
Actual vs. Estimated Effort



Actual vs. Estimated Schedule



Actual vs. Estimated Size



The Intelligence behind Successful Software Projects

In Summary

Å Average schedule growth is 8%

Å Average cost/effort growth is 16%

Å Average size growth is 15%

Å So how can we use this information to create more accurate estimates?

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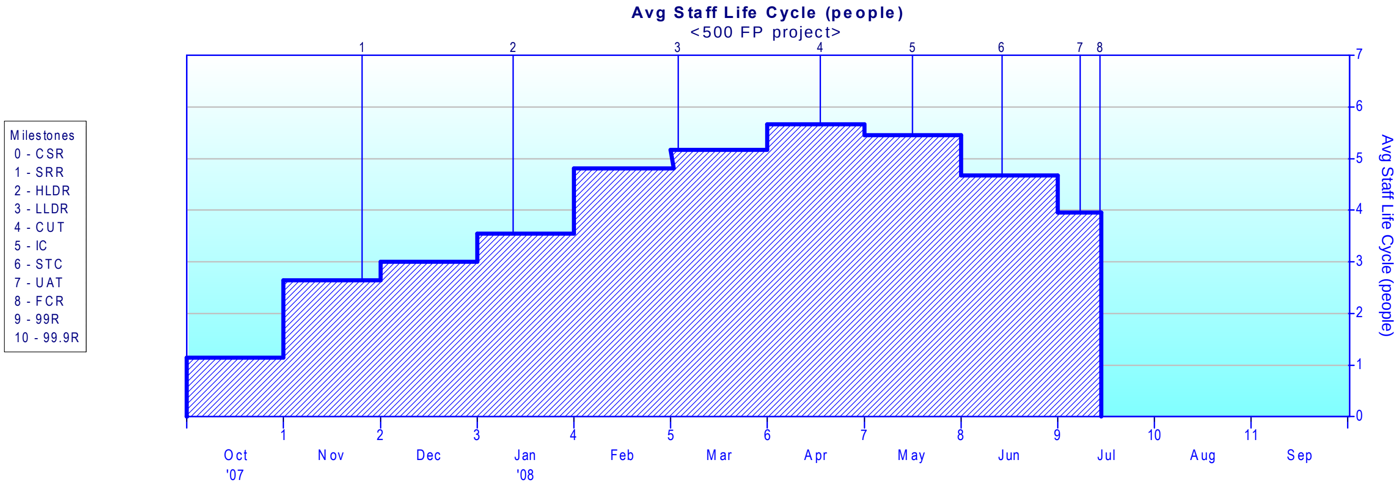
Modeling Increased Size

- Create best project estimate based on proposed size
  - Use historically based productivity
  - Account for project constraints (staff, effort, schedule)
- Create estimate based on 15% size growth
  - Does this account for projected schedule & effort growth?

500 FP Project

Staffing & Probability Analysis



SOLUTION PANEL - <500 FP project>

	C&T	Life Cycle	
Duration	6.7	9.4	Months
Effort	29	37	PM
Cost	493.4	643.6	$ (K)
Peak Staff	5.7	5.7	people
MTTD	1.823	1.823	Days
Start Date	12/23/2007	10/1/2007	

PI=16.5 MBI=3.6 Eff FP=500

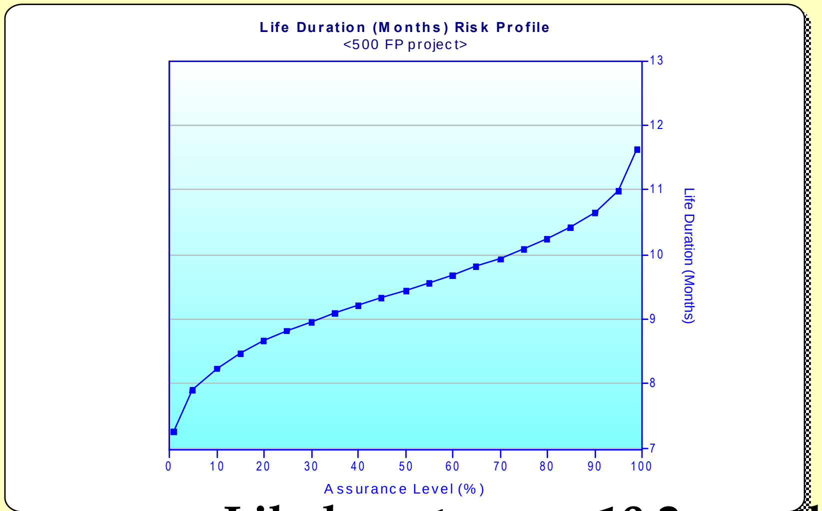
9.4 months duration

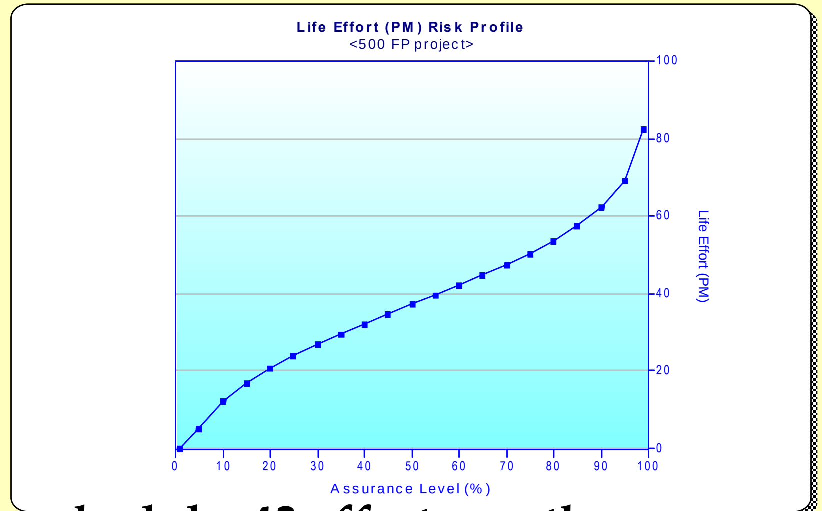
37 person months effort

50% probability

500 FP Project

Evaluate Probability of Current Estimate





Likely outcomes 10.2 months schedule, 43 effort months

Life Duration (Months) Risk Profile - Probability demo
<500 FP project>

Assurance Level (%)	Life Duration (Months)
1	7.26
5	7.90
10	8.25
15	8.48
20	8.66
25	8.82
30	8.96
35	9.09
40	9.21
45	9.33
50	9.45
55	9.57
60	9.69
65	9.81
70	9.94
75	10.08
80	10.24
85	10.42

Life Effort (PM) Risk Profile - Probability demo
<500 FP project>

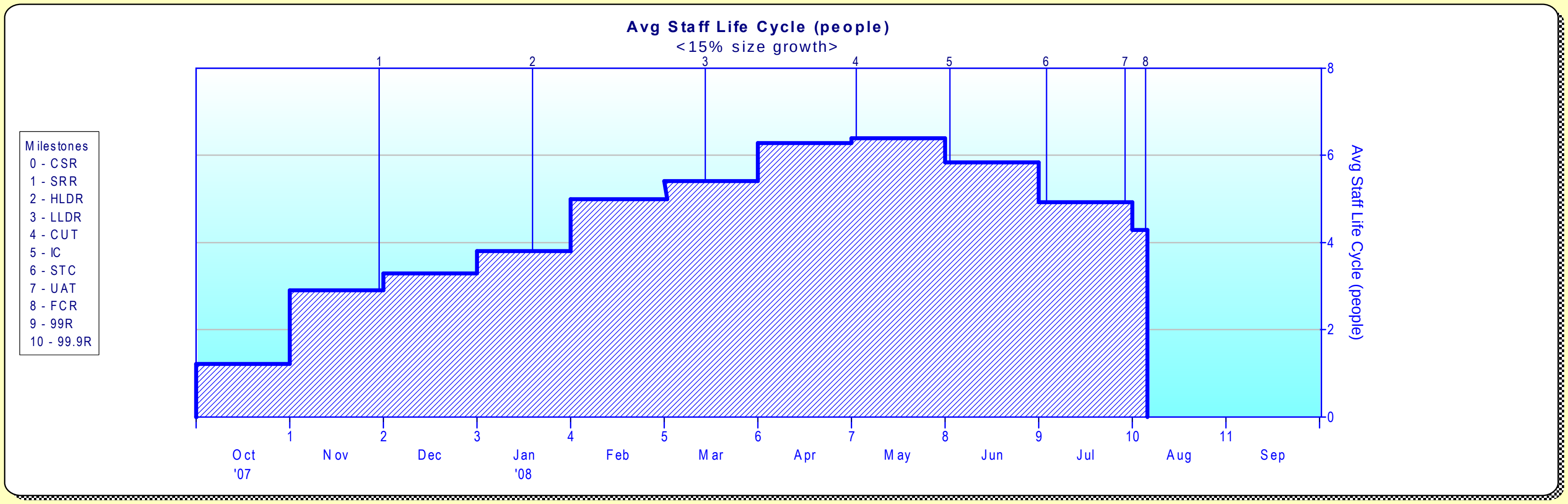
Assurance Level (%)	Life Effort (PM)
1	0.00
5	5.11
10	12.20
15	16.99
20	20.79
25	24.05
30	26.98
35	29.69
40	32.27
45	34.75
50	37.20
55	39.65
60	42.13
65	44.71
70	47.42
75	50.35
80	53.61
85	57.41

Project: Probability demo

The Intelligence behind Successful Software Projects

15% Growth (575 FP)

Staffing & Probability Analysis



SOLUTION PANEL - <15% size growth>

	C&T	Life Cycle	
Duration	7.3	10.2	Months
Effort	35	46	PM
Cost	603.7	787.5	$ (K)
Peak Staff	6.5	6.5	people
MTTD	1.681	1.681	Days
Start Date	12/28/2007	10/1/2007	

PI=16.5 MBI=3.4 Eff FP=575

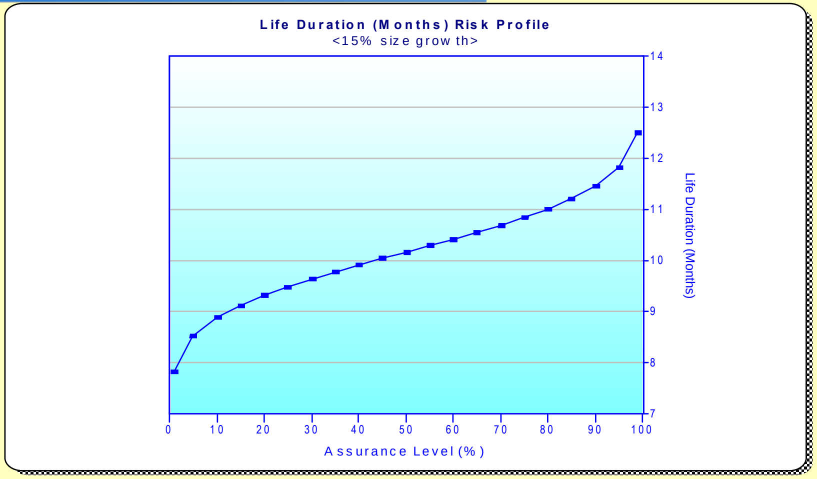
10.2 months duration

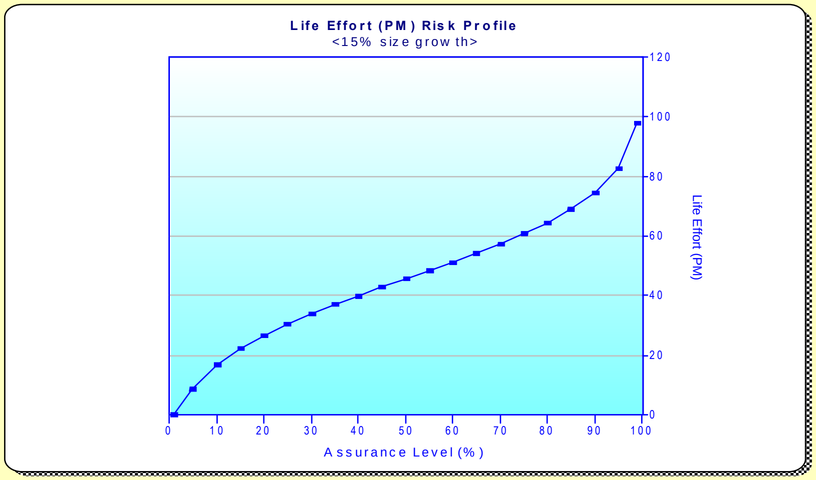
46 person months effort

The Intelligence behind Successful Software Projects

15% Growth (575 FP)

Evaluate Probability of Current Estimate





Life Duration (Months) Risk Profile - Probability demo
<15% size growth>

Assurance Level (%)	Life Duration (Months)
1	7.83
5	8.51
10	8.88
15	9.12
20	9.32
25	9.48
30	9.63
35	9.77
40	9.91
45	10.03
50	10.16
55	10.2[illegible]
60	10.41
65	10.55
70	10.69
75	10.84
80	11.00
85	11.20

Life Effort (PM) Risk Profile - Probability demo
<15% size growth>

Assurance Level (%)	Life Effort (PM)
1	0.00
5	8.61
10	16.76
15	22.27
20	26.64
25	30.39
30	33.76
35	36.89
40	39.85
45	42.71
50	45.52
55	48.33
60	51.19
65	54.15
70	57.28
75	60.65
80	64.40
85	68.77

Project Probability demo

Averages close to numbers predicted for effort and schedule growth (10.2 duration and 43 staff months of effort)

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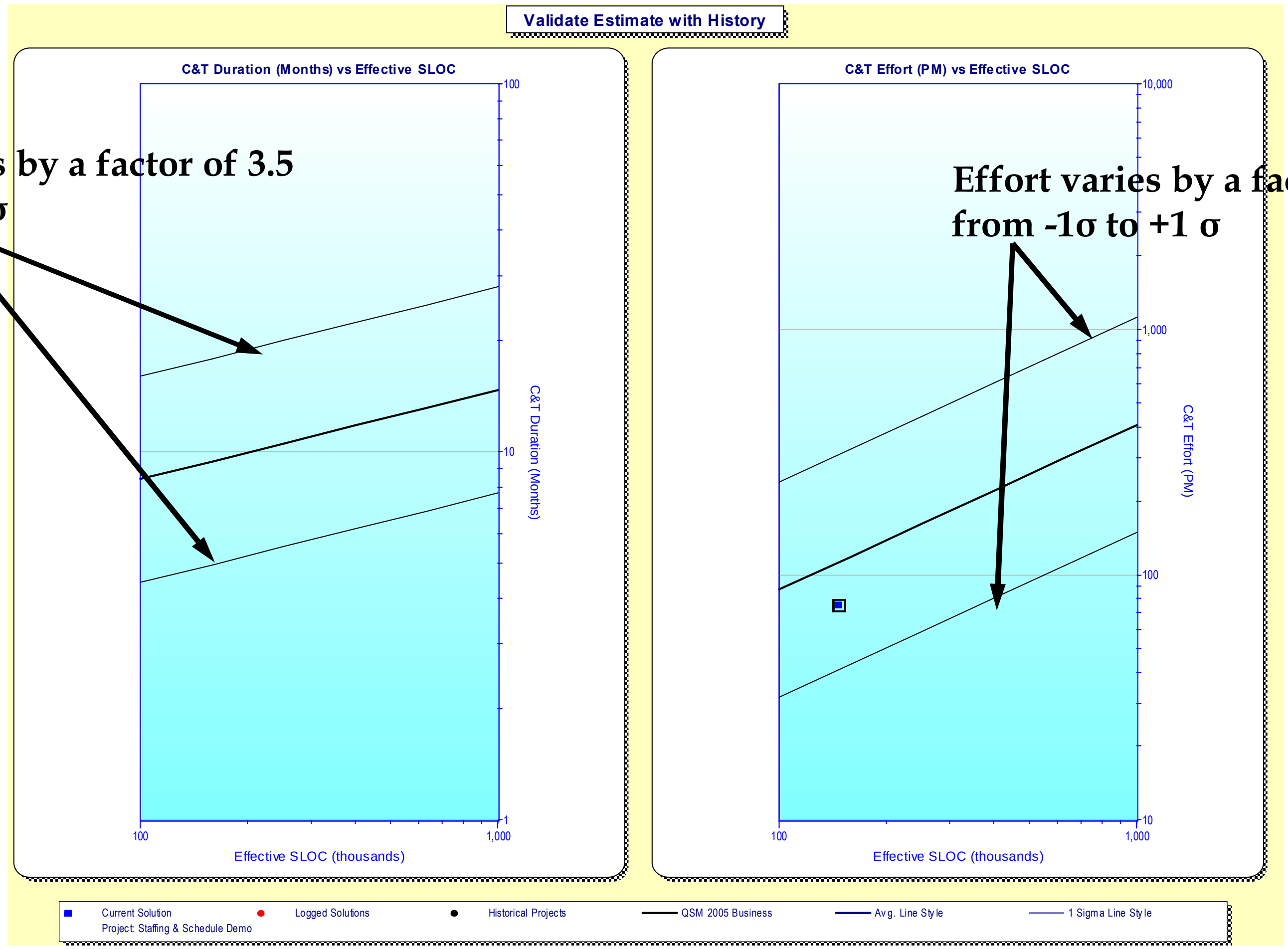
Staffing & Schedule

Schedule varies by a factor of 3.5 from -1σ to +1 σ

Effort varies by a factor of 8 from -1σ to +1 σ



What is "normal" variability?

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…d Project Effort Be Expended
A Case Study

- 838 projects that had data reported for Analysis/Design as well as Construction and Test phases
- Average Effort applied to Analysis/Design = 20%
- 474 projects in the sample used <= 20% design effort
  - Average Analysis/Design Effort = 11%
- 364 projects in the sample used > 20% design effort
  - Average Analysis/Design Effort = 33%
- Size profiles of samples very similar

The Intelligence behind Successful Software Projects

Observations

- Projects with <20% effort in Requirements and Design
  - Took 12% longer to complete
  - Averaged 5.6% more effort (median 24.4% greater)
  - Had an average staff 14.6% higher
- But these projects did excel at one thing:
  - Found 63.7% more defects in systems test
  - Had 127% more defects in the first 12 months after delivery

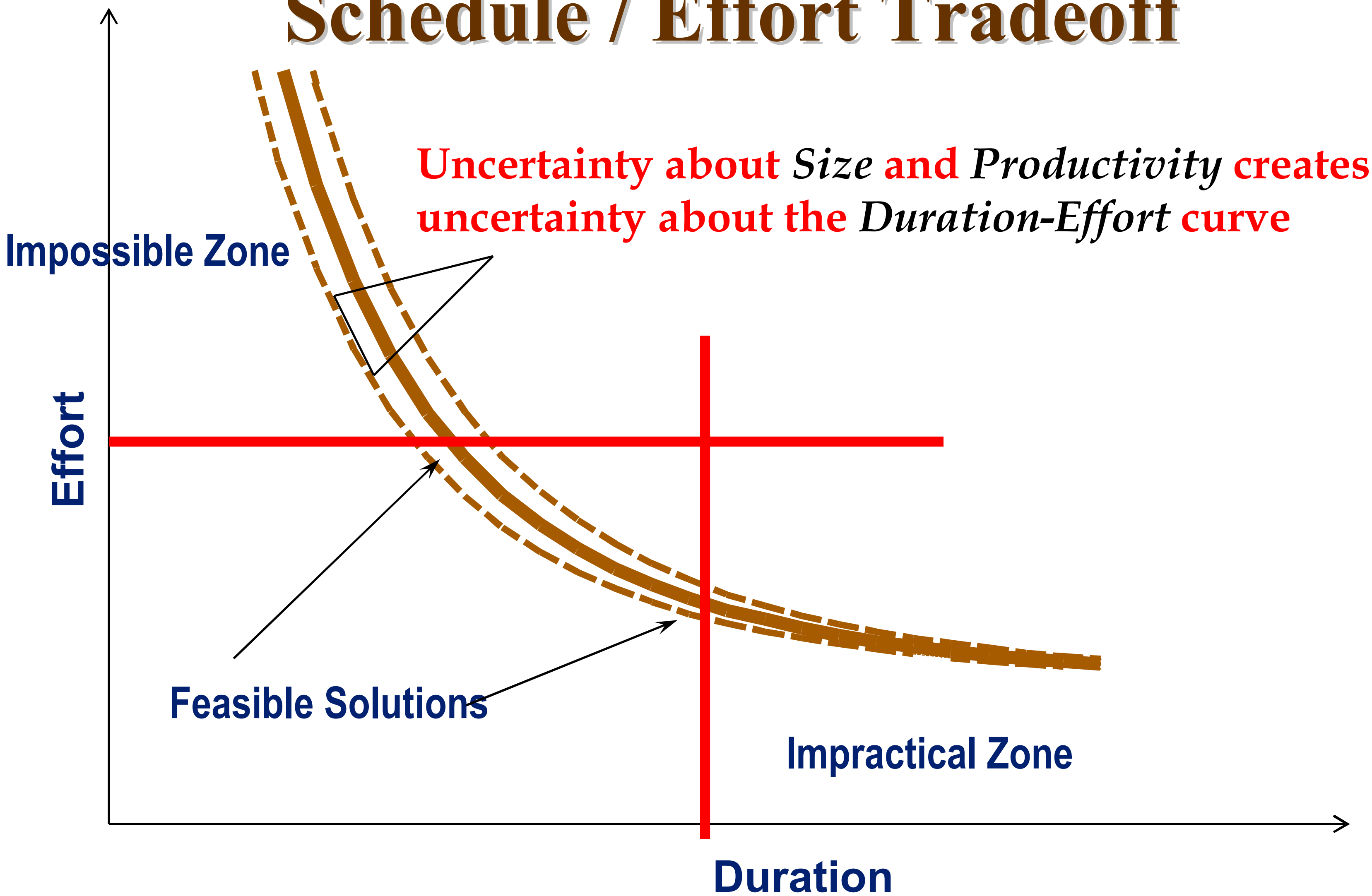
Understanding Trade-offs

$$\textbf{Size} = \textbf{Effort}^{a} \times \textbf{Time}^{b} \times \textbf{Productivity}$$

$$\text{where } a = \frac{1}{3} \text{ and } b = \frac{4}{3}$$

Additional schedule has a much larger impact on a software project than increased effort

Estimating Conundrum
Schedule / Effort Tradeoff



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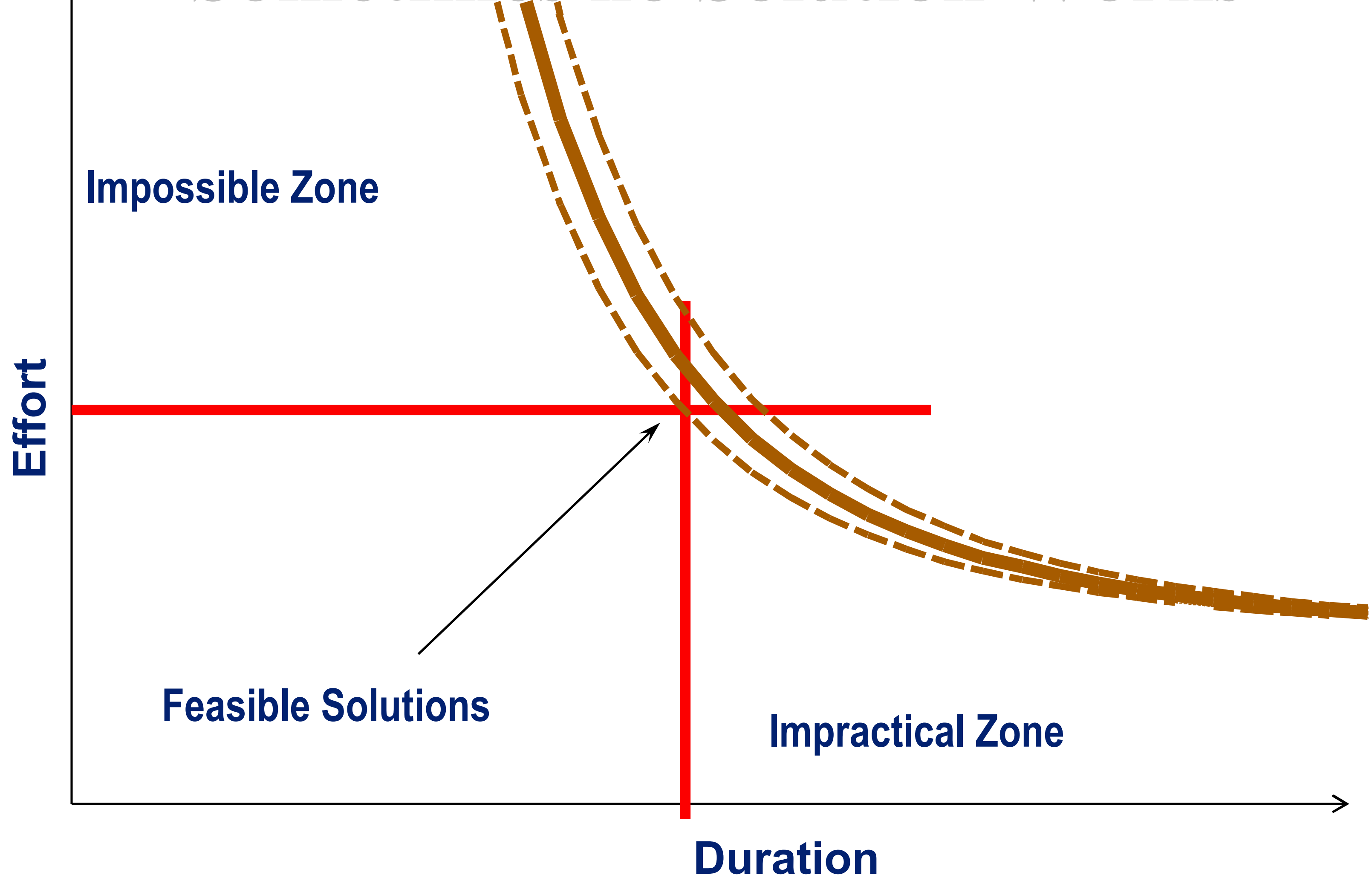
Estimating Conundrum Sometimes no Solution Works



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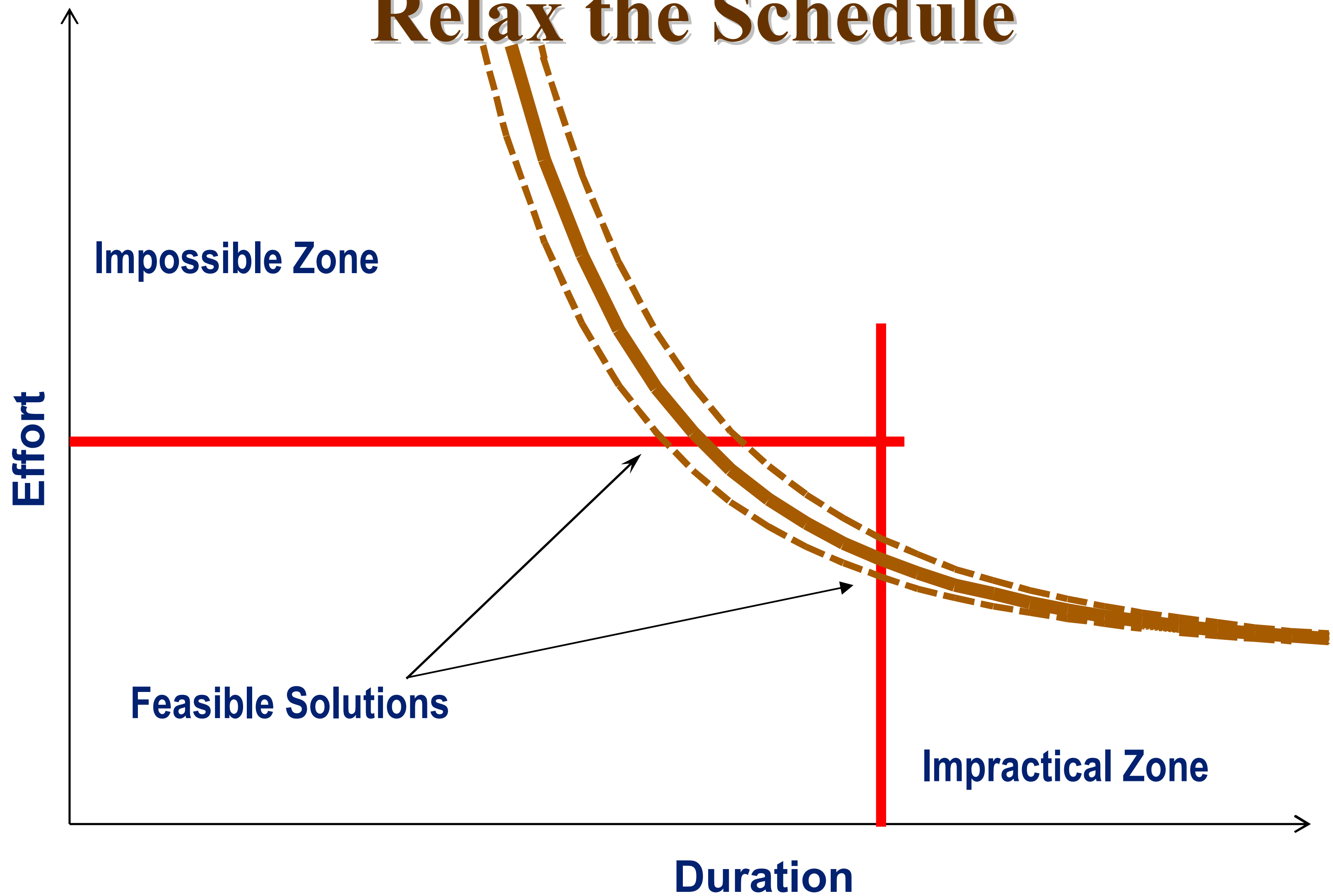
Estimating Conundrum
Relax the Schedule



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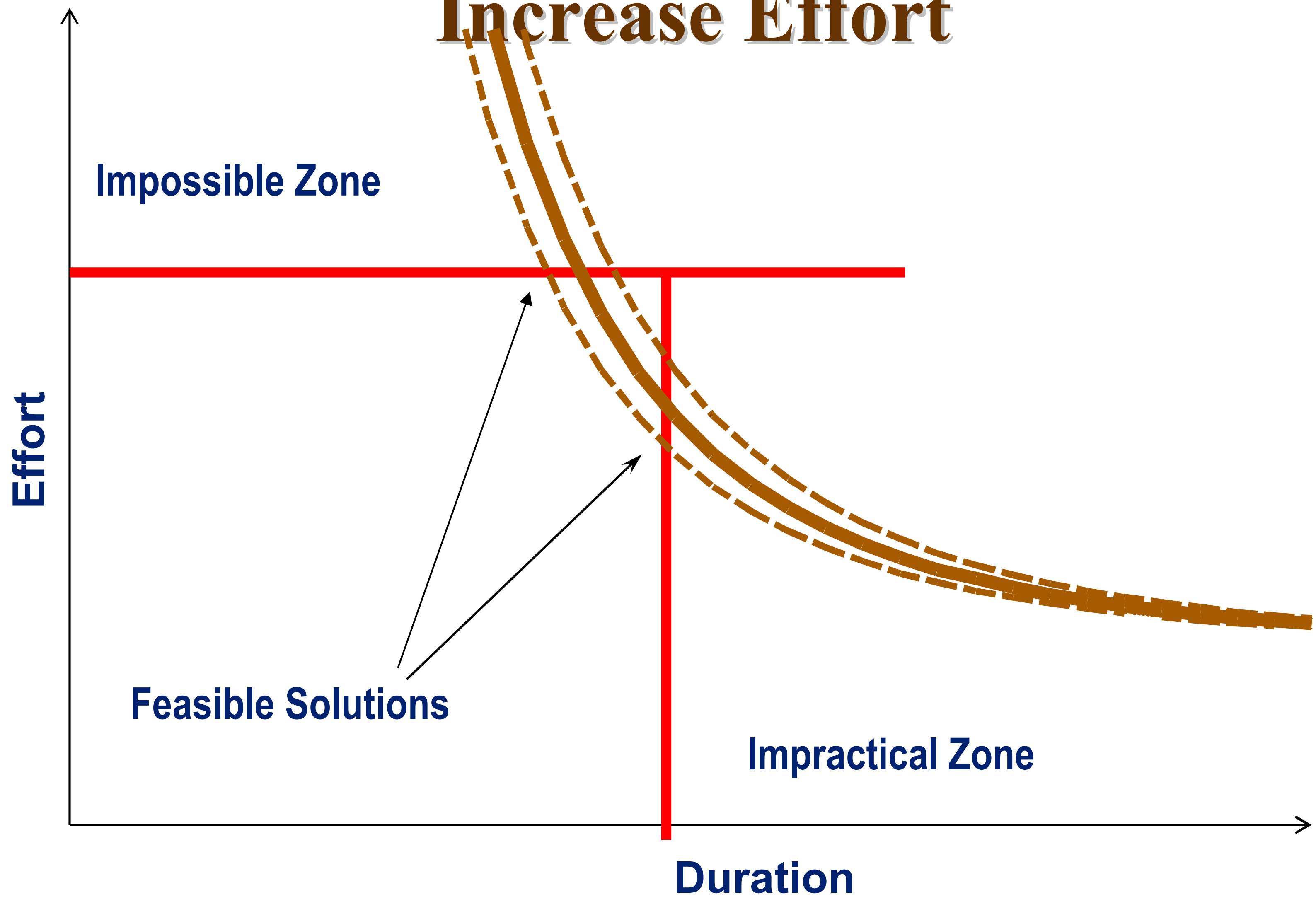
Estimating Conundrum
Increase Effort



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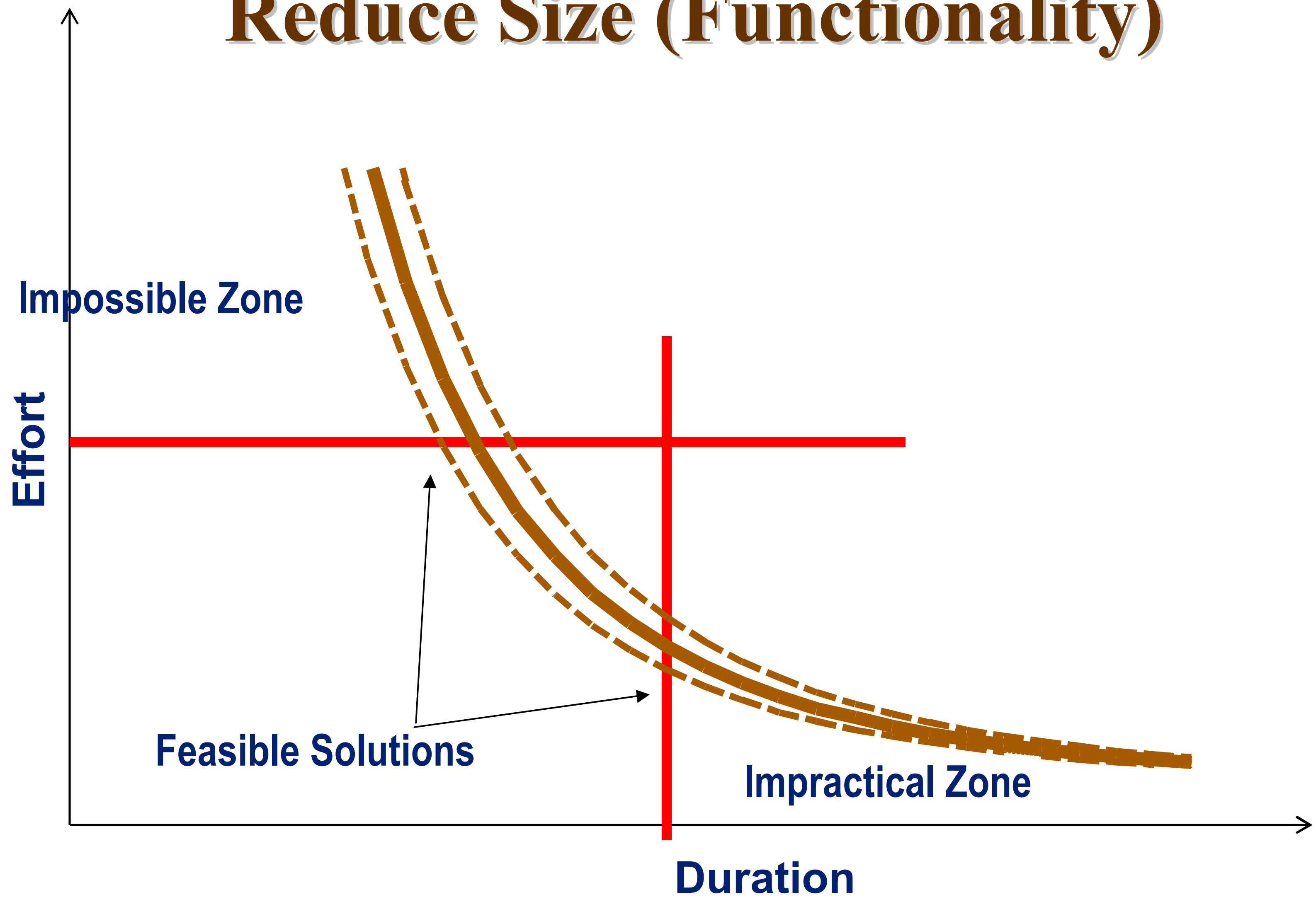
Estimating Conundrum
Reduce Size (Functionality)



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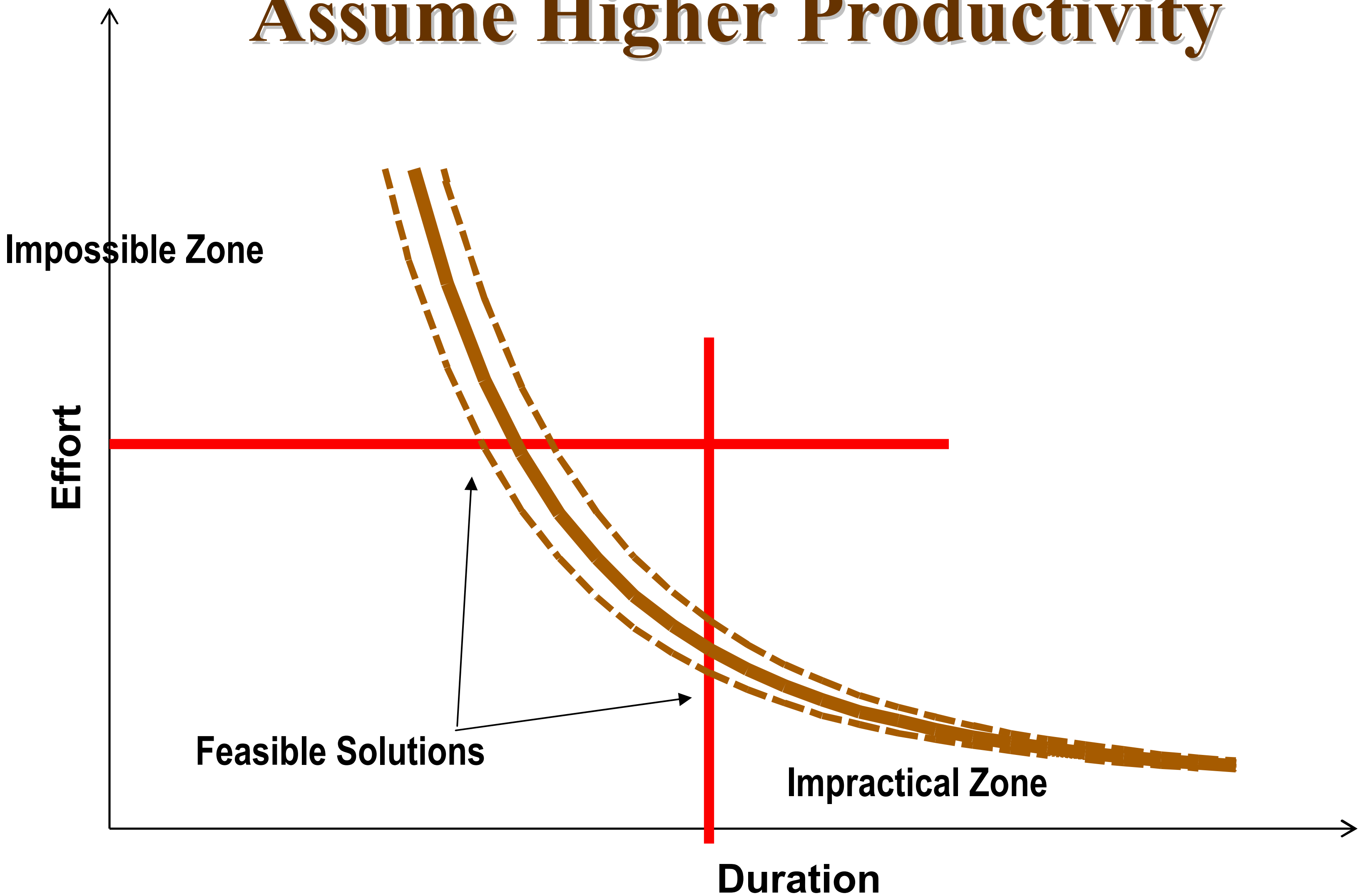
Estimating Conundrum Assume Higher Productivity



The Intelligence behind Successful Software Projects

Conclusions

- Measurement is an integral part of management
- Information required to make precise estimates is unavailable at project start-up
  - Estimate uncertainty decreases rapidly with more information
- Project estimates understate effort, schedule, & size
  - Estimating based on a larger size or at a higher assurance level can account for this
- The trade-off between schedule & cost/effort is non-linear

The Intelligence behind Successful Software Projects

Conclusions

- Effort spent in Analysis & Design pays big dividends
  - Reduces overall project effort (cost$$$$)
  - Reduces overall project schedule
  - Improves project quality

Questions ?

Optimizing the Measurement Process

Gary Natwick, Debra Perry, David Card
Harris Corporation / DNV

...ommunications ...ion: What We Do...

HARRIS

Aviation electronics

Communications and information networks

Intelligence, surveillance, and reconnaissance

Space and ground satellite communications systems

Operations and support services

We innovate, integrate, and manage technology.

- Introduction
  - Background
  - Goals and Objectives
  - Terminology
  - Approach
- Roadmap
  - Characteristics of Success
  - Measurement Analyst
  - User Viewpoints
  - Automation as an Enabler
  - Leading Indicators
- Results
  - Information Needs
  - Measurement Objectives
  - Executive Management Viewpoint
  - Indicator Improvements
  - Lessons Learned
- Summary

- Harris CMMI® Level 3 compliant since 11/2005
- Measurements used regularly for program monitor and control
- Need for improvement still recognized
- Measurement process relies on manual input
- Perception too many measures, some measures redundant
- Management desires increased emphasis on fact based decision making

Goals

HARRIS

Å Improve measurement and analysis effectiveness

ï Enhance measurement infrastructure to improve

Å Efficiency & value

Å Predictability

Å Competitive advantage

ï Reduce quantity of measures to effectively manage programs and align with division objectives

ï Increase number of leading indicators

Å Improve measurement foundation for advancement to CMMI® Level 4 or 5

Objectives

HARRIS

- Develop simple, consistent, reliable measurements
- Reuse or modify existing measurements
- Provide rapid access to fresh, actionable information
- Examine quality and completeness of data
- Increase consistency with industry standards
- Increase predictability of program execution
- Facilitate straight-forward and objective analysis of measures
- Enable automated collection of data and creation of indicators
- Evaluate adequacy of existing data to support high maturity analysis

inology

HARRIS

User Viewpoint

Level of Analysis and Flexibility

Measurement Specification

Level of Data Collection and Standardization

Repository Content

	Examples:	
Information Product	Program CPI Chart	Combination of Indicators and Interpretations
Indicator	CPI with Thresholds	Base or Derived Measure With Decision Criteria
Derived Measure	CPI = BCWP / ACWP	Function of Two or More Base Measures
Base Measure	BCWP, ACWP	Quantification of a Single Attribute
Attribute	Cost	Characteristic of a Process or Product

HARRIS

- Utilize an independent industry measurement expert to validate and achieve maximum results
- Identify classes of measurement users
- Define information needs of users, based on
  - User role and responsibilities
  - Business and improvement objectives
- Specify indicators
  - Define leading and concurrent indicators
  - Use existing measures where possible
- Conduct reviews with stakeholders
- Update command media
- Deploy incrementally

Å Characteristics of Success

Å Measurement Analyst

Å User Viewpoints

Å Automation as an Enabler

Å Leading Indicators

cs of Success

HARRIS

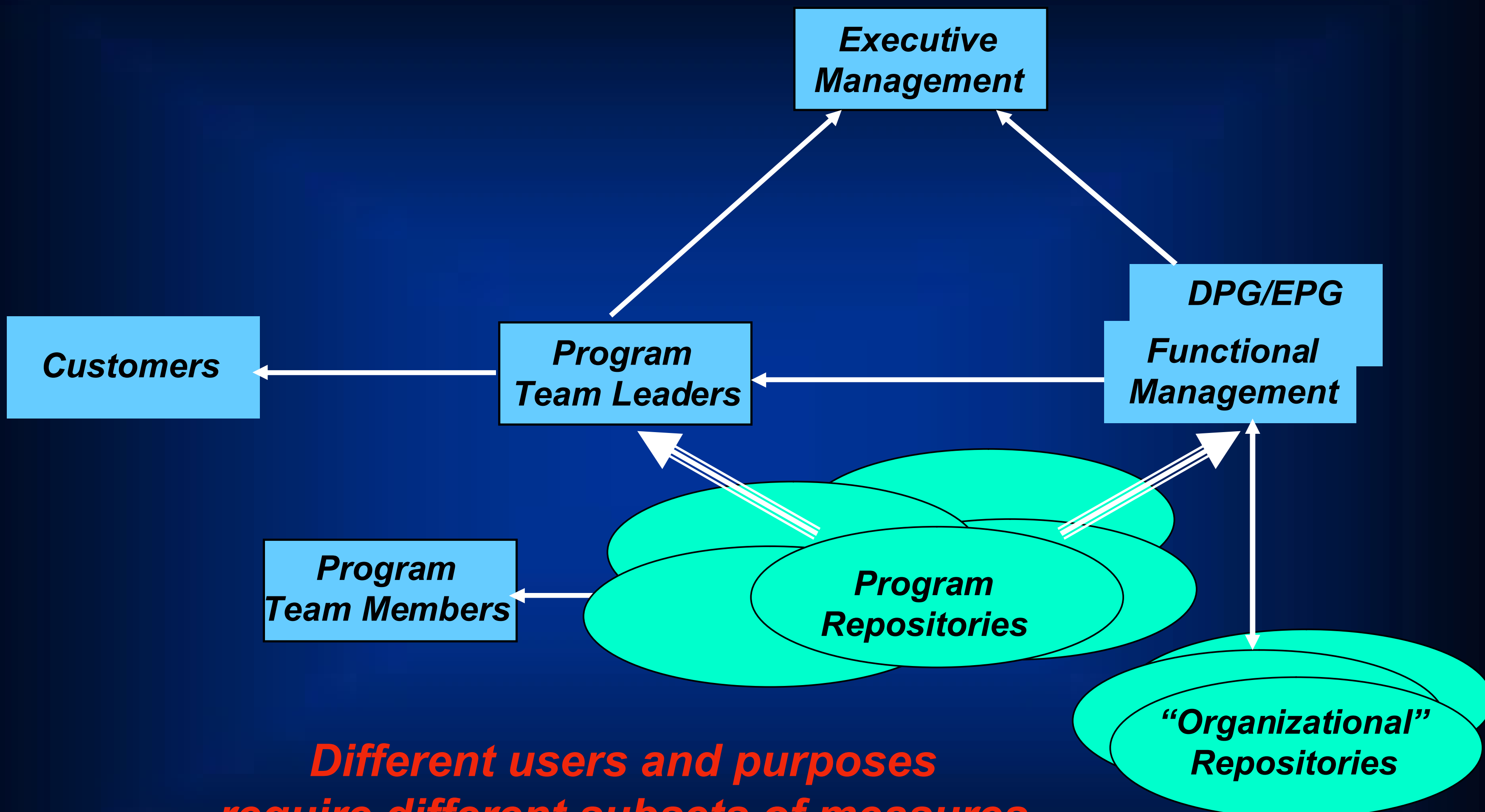
- Measures based on business goals
- Comprehensive measurement planning
- Measurement expertise
  - Training in defining, collecting and analyzing measures
  - Mentoring and advice
- Appropriate resources
  - Robust tool support
  - Measurement analysts
- Management support
- Broad participation

urement Analyst Role

- Use of measurement is a part of everyone's job
- Additional expertise maximizes effectiveness
  - Recognize significant trends
  - Communicate with data providers and decision makers
  - Efficient & consistent execution of measurement process
- Areas of expertise
  - Design/Plan measures and process
  - Training and mentoring
  - Analysis and interpretation to support decision makers
- Often a part time job
  - Program level support
  - Organizational level support

nts

HARRIS



Different users and purposes require different subsets of measures

r Automation

HARRIS

- More Timely Access to Data and Analysis
  - Makes data immediately available
  - Facilitates drill down to investigate anomalies
  - Makes information available in time to affect business and project outcomes
  - Facilitates gathering and analyzing data for lessons learned
  - Make data widely accessible
- Improved Data Quality
  - Ensures more complete data
  - Reduces transcription errors
  - Removes redundancy and inconsistency in data reporting
  - Easily supports users with different information needs
- Reduces effort for producing measurement reports

...ators

HARRIS

- Definition
  - Has predictive value, provides early warning of trouble (in time to affect the outcome)
- Types of leading indicators
  - Observed trends predict future results of that indicator
  - Changes in one indicator predicts future results of another indicator
  - Constraints that limit performance
- Obstacles for leading indicators
  - Cumulative measures and percentages
  - Inconsistent measurement definitions
  - Delays in data collection and analysis
  - Subjective criteria and reporting

- Information Needs
- Measurement Objectives
- Executive Management Viewpoint
- Indicator Improvements
- Lessons Learned

tion Needs

HARRIS

- Program Team Members
  - Implement processes effectively
  - Produce quality products
  - Complete tasks on-time
- Program Team Leaders
  - Estimate and plan
  - Monitor and control
- Customer
  - Monitor product quality
  - Monitor performance to plan
  - Verify appropriate capability delivered to field
- Functional Management
  - Develop improvement plans with measurable objectives
  - Improve functional processes across projects
  - Develop staff within functions
  - Provide historical data for estimating
- Executive Management
  - Provide program oversight (project by project)
  - Ensure overall process/organizational health (across projects)
  - Achieve organizational financial performance (across projects)

…gement Information Needs …nt Objectives

HARRIS

- Provide program oversight (program by program)
  - Meet customer expectations & satisfy the customer
  - Produce a high quality compliant product
  - Perform in accordance with the agreed to cost & schedule
  - Meet program objectives
- Ensure overall process/organizational health (across programs)
  - Increase productivity in all functions (increase effectiveness)
  - Reduce program rework (early & effective removal of defects across the product life cycle)
  - Increase predictability of program performance
  - Increase accuracy of program estimates
  - Maintain CMMI Level 3 maturity rating
  - Foster a rewarding & satisfying work experience for Harris employees
- Achieve organizational financial performance (across programs)
  - Meet Annual Operating Plan (AOP) objectives

nagement 1 of 5

- Provide program oversight (project by project)
  - Meet customer expectations and satisfy the customer.
    - Technical Performance Measures
    - ƀ Risk Summary
    - Award Fee Graphs
    - Customer Satisfaction Data
  - Produce a high quality compliant product.
    - ƀ Defects by Phase
    - Defects Currently Open and Total Closed
    - Defect Severity Tracking
    - Technical Performance Measures
    - ƀ Process Compliance Data

ƀ indicates leading indicator

nagement 2 of 5

- Provide program oversight (project by project)
  - Perform in accordance with the agreed to cost and schedule.
    - Milestone Progress
    - Staffing Tracking
    - Requirements Tracking
    - EVMS Tracking
  - Deliver the expected Return on Sales (ROS) on the project.
    - Investment Profile
    - Financial Objectives
    - Sales, Order, Profit Tracking

...nagement 3 of 5

HARRIS

- Ensure overall process/organizational health (across programs)
  - Increase productivity in all functions
    - Efficiency Measures
  - Reduce project rework
    - Rework Effort Tracking
    - Defect Phase Containment Tracking
  - Increase predictability of project performance
    - Earned Value Management System (EVMS) Reports
  - Increase accuracy of project estimates
    - Project Characterization Worksheet Analysis by Function

nagement 4 of 5

- Å Ensure overall process/organizational health (across programs)
  - ï Maintain CMMI® Level 3 maturity rating
    - Åþ Process Compliance Data
  - ï Foster a rewarding and satisfying work experience for Harris employees
    - Å Organizational Training Reports
    - Å Employee Engagement Surveys

nagement 5 of 5

- Achieve organizational financial performance (across programs)
  - Meet AOP objectives
    - Investment Profile
    - Financial Objectives
    - Award Fee Tracking
    - Sales, Order, Profit Tracking

rovements

HARRIS

- Number of overall Indicators needed was reduced
- Number of leading indicators was increased
- Some objective indicators added to balance subjective indicators

ned

- Using a systematic framework helps organize the process
- Measurement process needs to evolve with the organization
- Tool considerations canõt be ignored
- Objective, external advice helps validate
- Expect resistance to change
- Efficiency measures should be determined by the functional organizations

HARRIS

- CMMI® compliance doesn't ensure and efficient and effective measurement program
- A systematic approach is essential to balancing user measurement needs
- Next Steps
  - Develop Executive Management viewpoint first
    - Set expectations for leadership & program teams
    - Refine business objectives
  - Develop other user viewpoints over time
  - Measurement & Analysis training
  - Develop a Business Intelligence (BI) architecture, design and deployment plan

mation

HARRIS

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ÅCo-editor ISO/IEC Standard 15939: Software Measurement Process (International Organization for Standardization, 2002)
ÅEditor-in-Chief of the Journal of Systems and Software

Lessons Learned in the Implementation of Measurement Techniques for CMMI GP 2.8

Susanna Schwab
November 2007

nunications

communications
Enterprise IT Solutions

Å **Major supplier of a broad range of products**
Å **Major subsystem supplier**
Å **Becoming a system supplier in:**
ï ISR
ï Training
ï Aircraft modernization and O&M
ï Government services
Å **Major provider of national security solutions in:**
ï C4ISR
ï Homeland security and defense/GWOT*
ï Government enterprise IT
ï Transformational programs

* Global War on Terrorism (GWOT)

se IT Solutions (EITS) vision Overview

communications
Enterprise IT Solutions

Å Organization: **Division of L-3 Communications**

Å Employees: **Over 2,000 professionals**

Å Headquarters: **Reston, VA**

Å **Chartered to support civil and defense Government agencies**

Å Mission: **Provide world-class enterprise information technology (IT), communications, and engineering services and solutions to the public sector.**

Å Vision: **Become the Government's trusted partner for exceptional IT, communications, and engineering services and solutions; and achieve a challenging and rewarding work environment.**

...se IT Solutions (EITS) ...anizational Profile

L3 communications
Enterprise IT Solutions

- **EITS Division composed of diverse business units operating under multiple industry models and standards (CMMI, ISO 20000, ITIL, PMBOK)**
- **Government and public agency customer base**
  - **NASA (National Air and Space Administration) – IV&V (independent verification and validation services) ; CMMI ML 3 Objective**
  - Metropolitan airport authorities (business process engineering) CMMI ML 3 Objective
  - County School Systems (IT infrastructure and support) ISO 20000 Objective
  - Federal Government (staff augmentation) CMMI ML3 Objective
  - FAA (Federal Aeronautics Administration software development) CMMI ML 3 Objective
- **Many (sometimes very) small projects in**
  - software development functional area (CMMI, PMBOK))
  - managed services functional area (ISO 20000, ITIL, PMBOK)
- **Staff augmentation projects predominate** (CMMI, PMBOK)

easurement Program Requirements

L3 communications
Enterprise IT Solutions

Å EITS measurement program must efficiently support CMMI, ISO 20000 (ITIL), PMBOK best practices

Å EITS measurement process assets must be tailorable to diverse functional areas (managed services, staff augmentation)

Å EITS measurement activities must have minimum impact on limited project staff

easurement Program Challenges

L3 communications
Enterprise IT Solutions

- Customizing measurement solutions for non-homogenous business and functional areas
- Selecting the ñrightò measurements to best support business goals
- Cost effective staffing of measurement activities in small short term projects with minimal resources
- Effective monitoring and control of CMMI process areas with minimal measurement resources
- Mapping CMMI model measurement best practices based on larger software development projects into small non software development projects
- Integrating and reusing measurements based on CMMI measurement practices to support implementation of other industry standards (ITIL, ISO 20000, PMBOK)

easurement Program
rea Monitor and Control

Generic Practice 2.8

"CMMI Guidelines for Process Integration and Product Improvement" Second Edition; Crissis, Konrad, Schrum 2006

"Monitor and control the process against the plan for performing the process and take appropriate corrective action ….

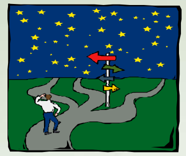
Subpractice 1. Measure actual performance against the plan for performing the process"

CMMI subpractices are optional - or are they?

nalizing CMMI GP 2.8 Case Study

communications
Enterprise IT Solutions

The Dilemma …



Apparent gaps uncovered during CMMI GP 2.8 implementation in EITS NASA IV&V projects

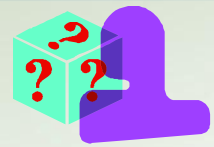
Å **Initial expectation:** existing IV&V measurement program adequately covered CMMI measurement requirements with only minor gaps

Å **Reality check:** generally the case except for CMMI requirements around institutionalization of GP 2.8

Å **Concern:** measurements would need to be implemented in all projects being appraised for all process areas at maturity levels 2 and 3 ï resulting in almost 30 new measurements per project!

nalizing CMMI GP 2.8 Case Study

The Questions …



- What sort of measurements are appropriate and useful to monitor and control each process area?
- Are measurements necessary for each process area being assessed?
- Are there alternative qualitative methods to monitor and control process areas?
- How do projects tailor monitor and control of process area quantitative or qualitative activities?
- How should senior management be informed and involved with monitor and control of process performance in projects?
- How can monitor and control of process be implemented in a time and cost effective manner?

nalizing CMMI GP 2.8 Case Study

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The Happy Ending ….

- EITS division + IV&V team chartered to map existing IV&V measurement to generic measurements and address any gaps
- almost 3 months of contentious discussion ensued in attempt to address gaps in least burdensome manner
- qualitative measurement alternatives suggested for low value process areas; a few simple to collect but useful measurements added
- solution strategy reviewed and approved

CMMI success !

…nalizing CMMI GP 2.8
…essons Learned

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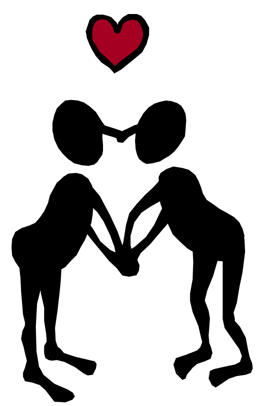
1) Use qualitative alternatives to measurement where appropriate

ï Strategically use qualitative alternatives to measurement (where appropriate) to minimize overhead

Aka K.I.S.S.



…onalizing CMMI GP 2.8 …mentation Strategies

L3 communications
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Build on the KISS principle

- CMMI GP 2.8 requires that monitor and control of process areas be institutionalized.
- Obvious mechanism to do this is to define measurements for each process area
- May be expensive, time consuming, and non value added
- Division defines suggested measurements for each process area but
- Projects identify key process areas for measurement and reporting ï other process areas are monitored and controlled qualitatively with reporting by exception

…nalizing CMMI GP 2.8 …essons Learned

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2) Carefully define measurement tailoring guidelines and validate tailoring execution

Generic division defined measurement	Tailored functional area measurement or alternative	Collection and analysis role	Reporting role and frequency
Actual cost compared to budget	Earned Value Cost Variance	Project Manager	Project Manager Monthly
Product defects	Number of formal customer issues	Functional area Quality System Manager	Quality System Manager Quarterly
Decision Analysis Review (DAR) scheduled versus actual	DAR performance stoplight	Functional Area QA auditor	Quality System Manager Quarterly

...nalizing CMMI GP 2.8 ...mentation Strategies

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Use Generic measurements with tailoring validation

- Generic measurements for process area monitoring and control specified at division level with tailoring guidelines
- Existing project measurements mapped to generic specifications
- Minimal set of additional measurements and qualitative alternatives identified, reviewed, approved and implemented

nalizing CMMI GP 2.8 essons Learned

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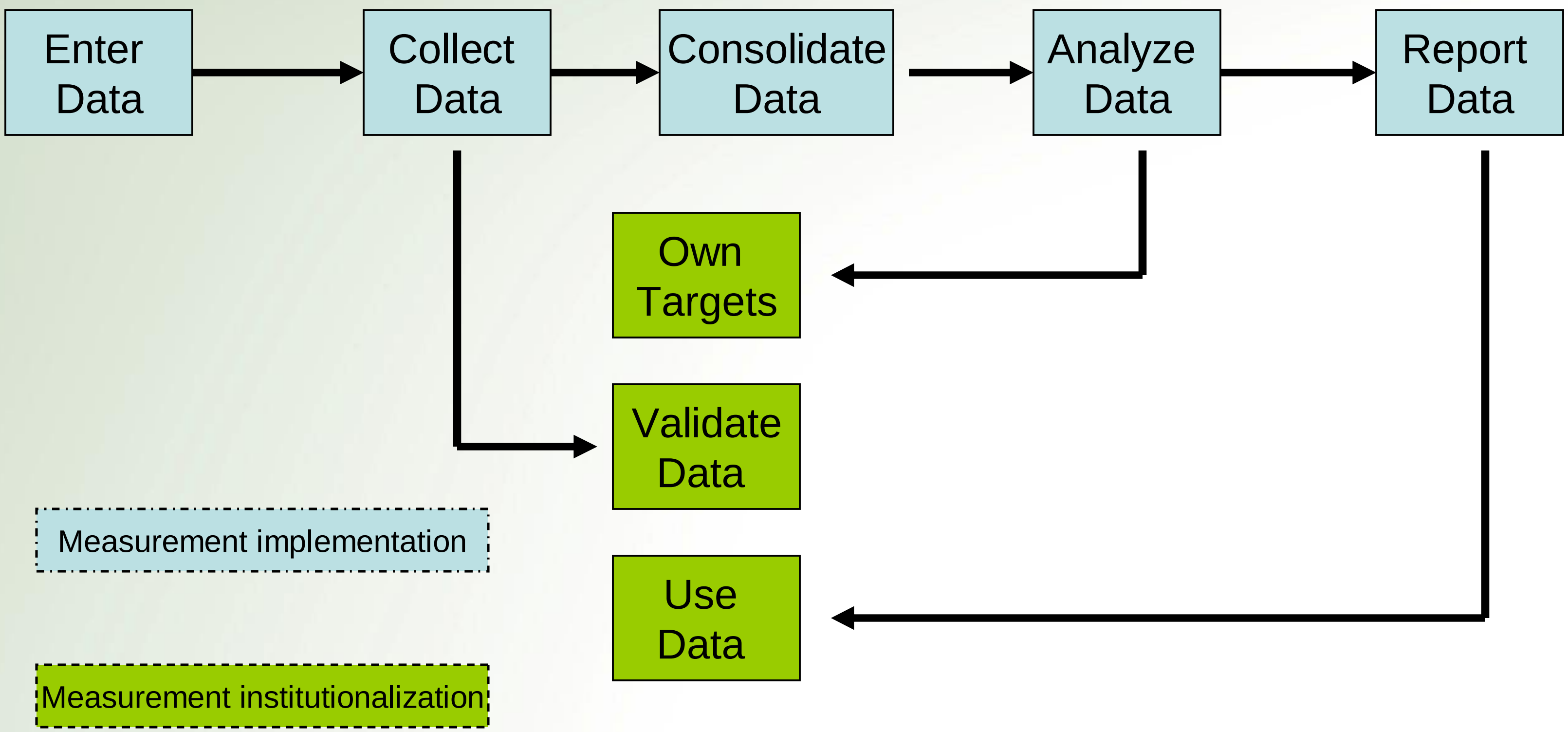
3) Collect and analyze measurements at highest possible level of organization



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"Push up" implementation

- Collect data at organizational level of related business goal
- Measurements supporting division goals collected, analyzed, and reported by division measurement roles
- Measurements supporting functional area goals collected, analyzed, and reported by functional area measurement roles
- Projects collect and report only project operational measurements

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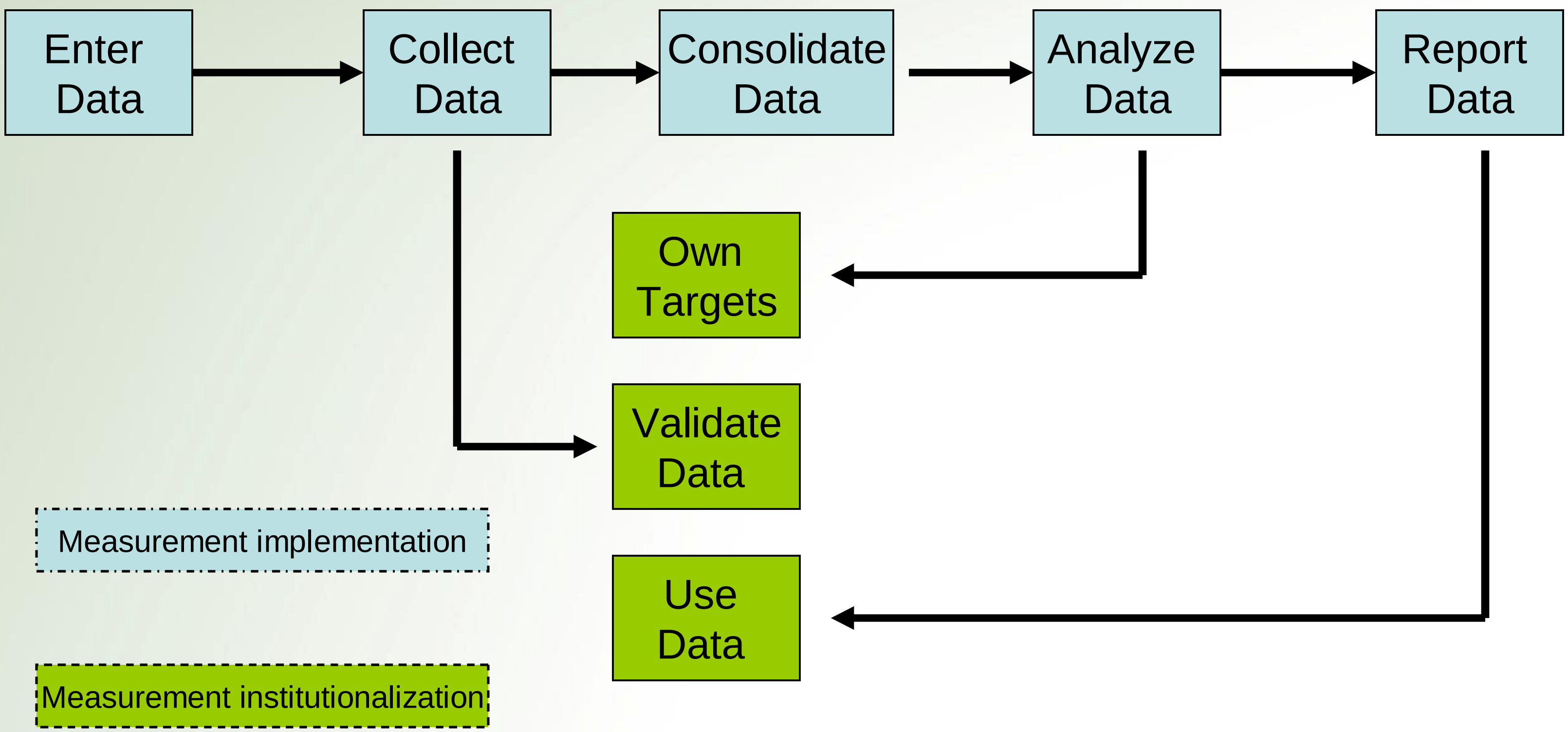
4) Push institutionalization down to lowest organizational levels



…nalizing CMMI GP 2.8 …mentation Strategies

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"Push down" institutionalization

- Measurements supporting process goals for common processes collected, analyzed, and reported by higher organizational level but é
- Projects collect and report project operational measurements
- Projects ***receive and use measurements reported by all organizational levels***

nalizing CMMI GP 2.8 essons Learned

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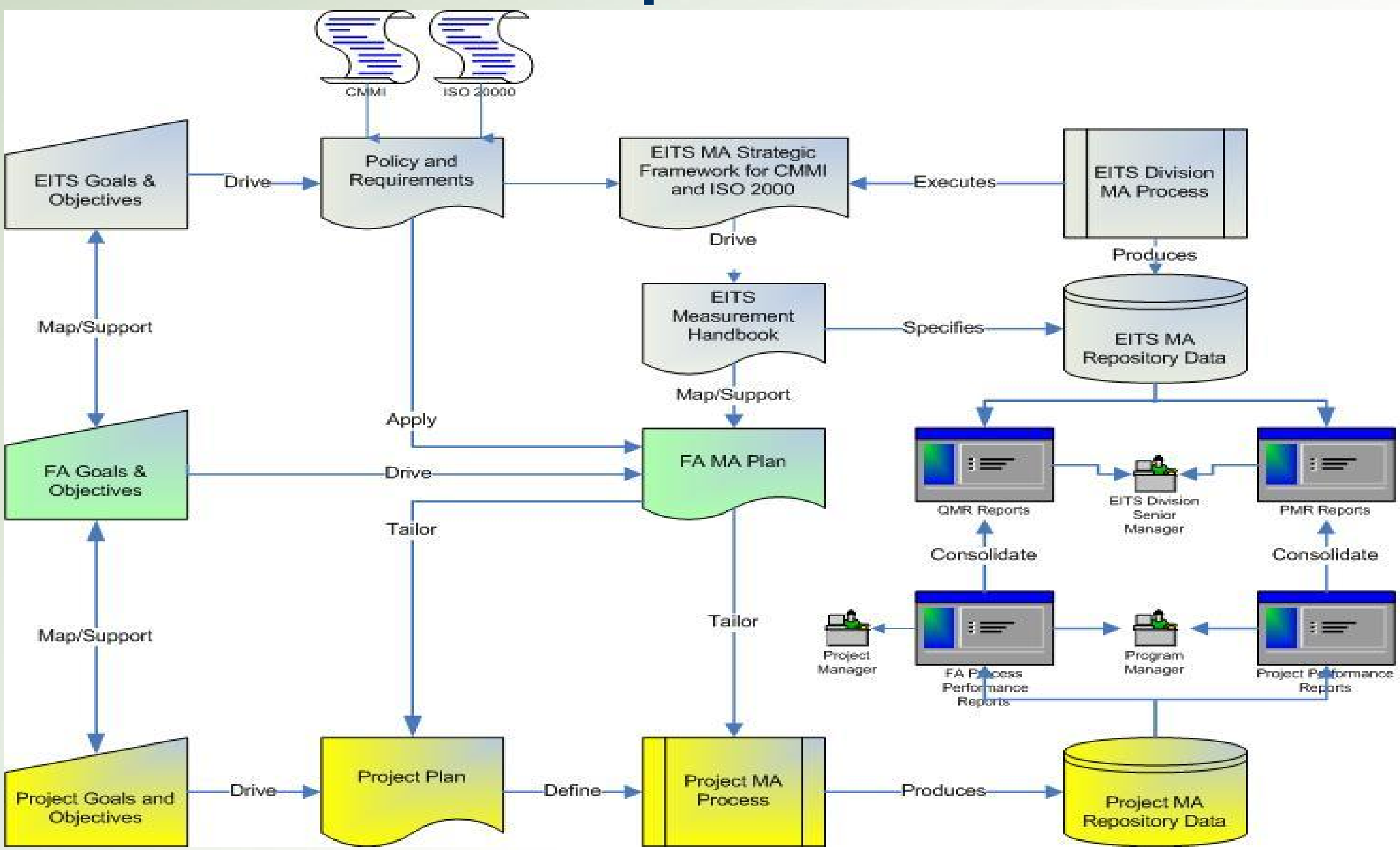
5) Leverage organizational measurement resources and best practices



...nalizing CMMI GP 2.8 ...mentation Strategies

Leveraging organizational assets and best practices

- Division develops measurement framework (specifications, tailoring guidance, interfaces) to support all standards and practices
- Functional areas develop application specific measurement planning frameworks with tailoring guidance ; best practices shared
- Projects tailor from functional area measurement planning framework; best practices shared

…nalizing CMMI GP 2.8
… Implementation Summary

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Measurement program preparation for CMMI ML3 appraisal of NASA IV&V projects

- Generic measurements for process area monitoring and control specified at division level
- Existing IV&V measurements mapped to generic measurements; gaps identified
- Division/IV&V working team chartered to address gaps
- Minimal set of additional measurements and qualitative alternatives identified, reviewed, approved and implemented

…nalizing CMMI GP 2.8
…ns Learned Summary

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- ✓ Use qualitative alternatives to measurement where appropriate
- ✓ Carefully define measurement tailoring guidelines and validate tailoring execution
- ✓ Collect and analyze measurements at highest possible level of organization
- ✓ Push institutionalization down to lowest organizational levels
- ✓ Leverage organizational measurement resources and best practices

nformation

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DEFINING THE FUTURE

Measurement Strategies in the CMMI

CMMI Technology Conference & User Group
12-15 November 2007

Rick Hefner, Ph.D.
Director, Process Management
Northrop Grumman Corporation
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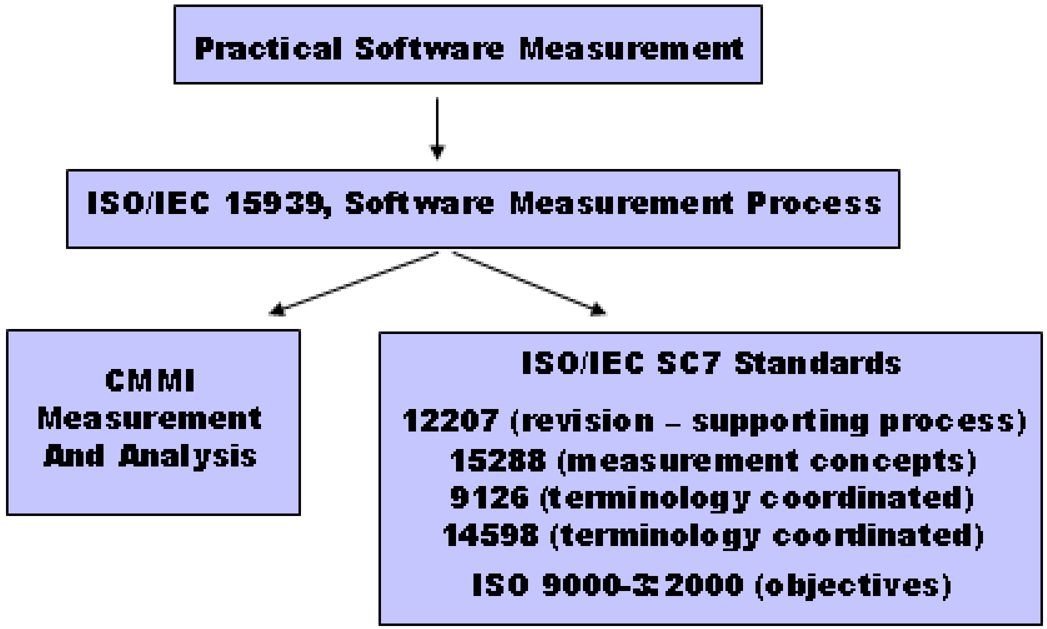
Background

- Software measurement remains a challenge for many projects and organizations
- It is difficult to select a set of measures that are easy to define and collect, yet offer real insight into progress, process, and quality
- This presentation will discuss strategies for starting and enhancing a CMMI-compliant measurement system

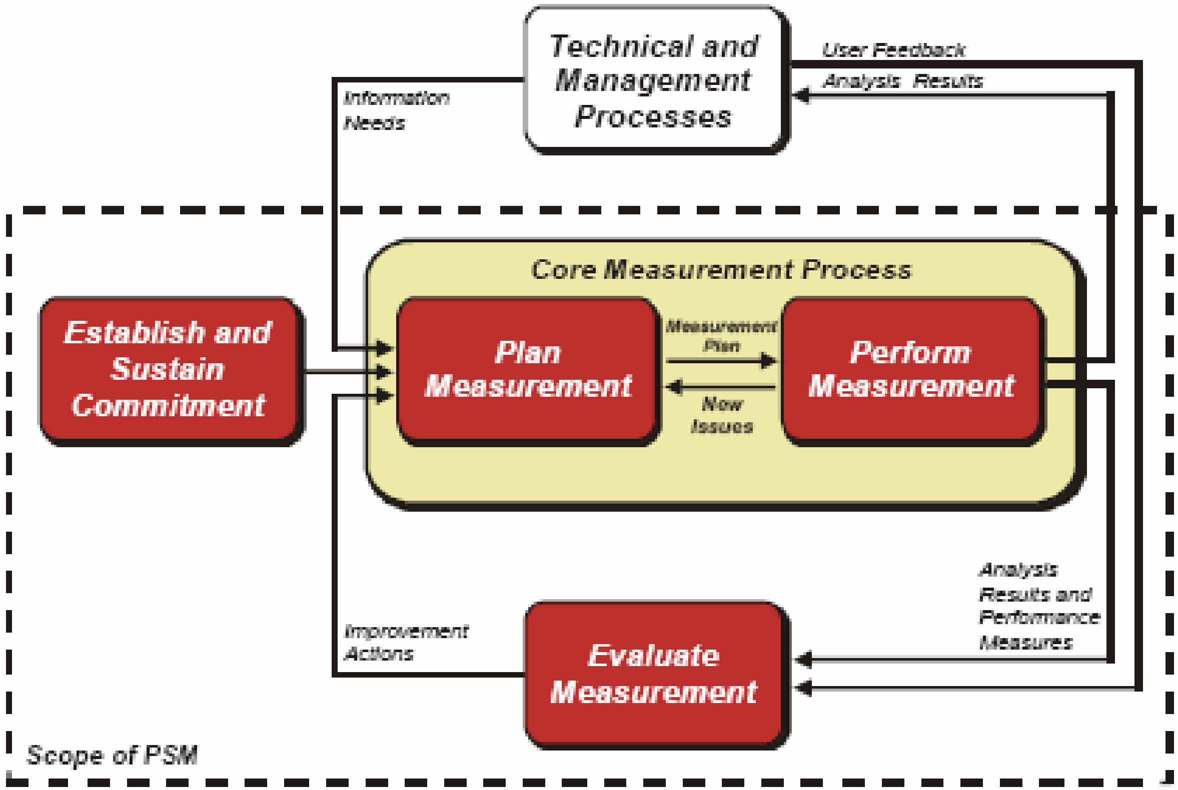
Measurement and Analysis Process Area

- **Purpose**
  - Develop and sustain a measurement capability that is used to support management information needs
- **Involves specifying:**
  - Information needs and measurement objectives
  - Measures
  - Data collection and storage mechanisms
  - Analysis techniques
  - Reporting and feedback mechanisms
- **Written to conform to ISO/IEC 15939, Software Engineering – Software Measurement Process**



Measurement Principles

- Measurement is a consistent but flexible process that must be tailored to the unique information needs and characteristics of the project or organization
- Decision makers must understand what is being measured and trust the information
- Measurement must be used to be meaningful



Reference: http://www.psmsc.com

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Multi-Level Measurement Requirements

- **Different types of information are needed at different levels of the infrastructure**

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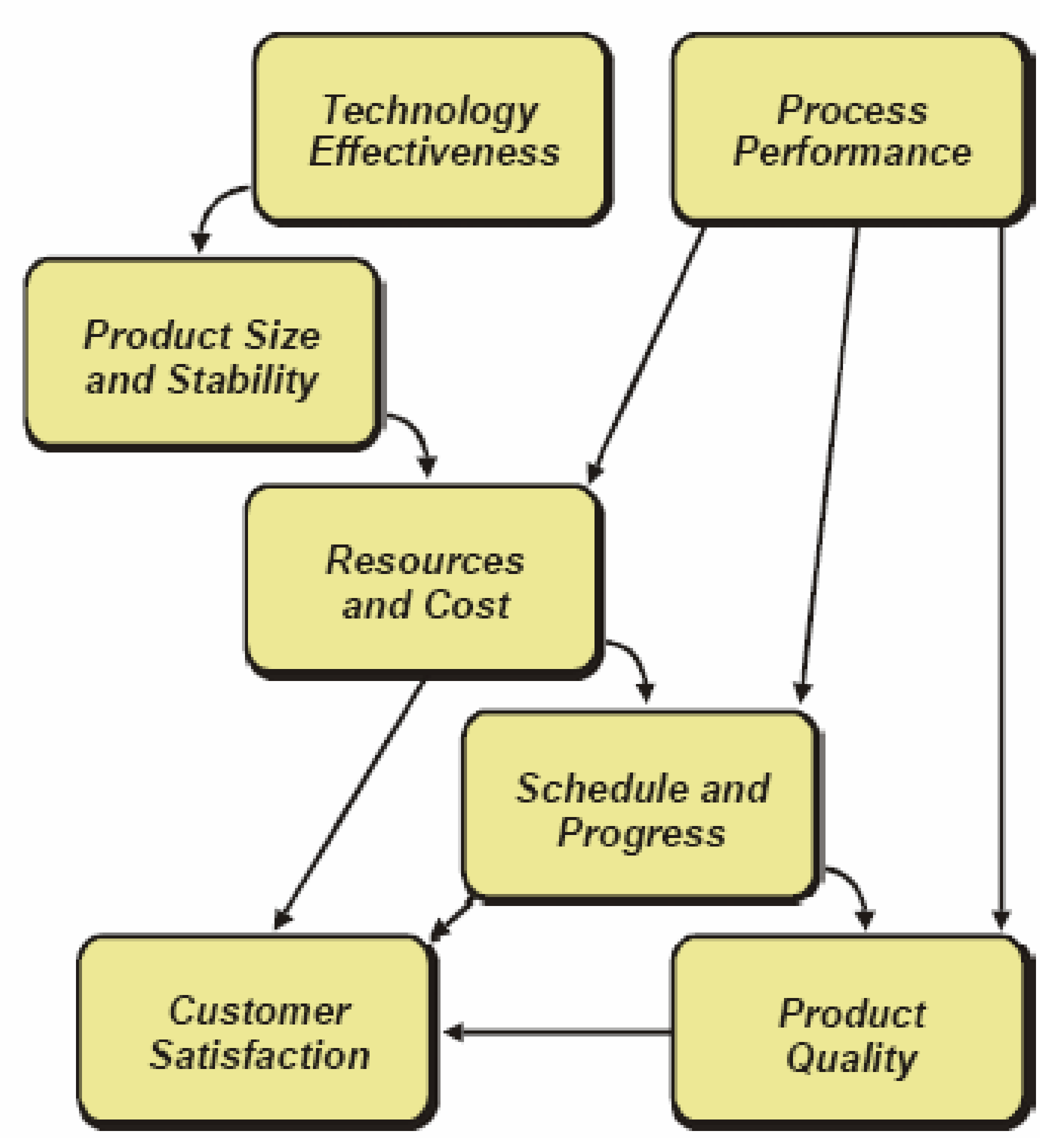
Rick Hefner, "Measurement Strategies in the CMMI", 24 April 2007

Practical Software and Systems Measurement

Analysis Model



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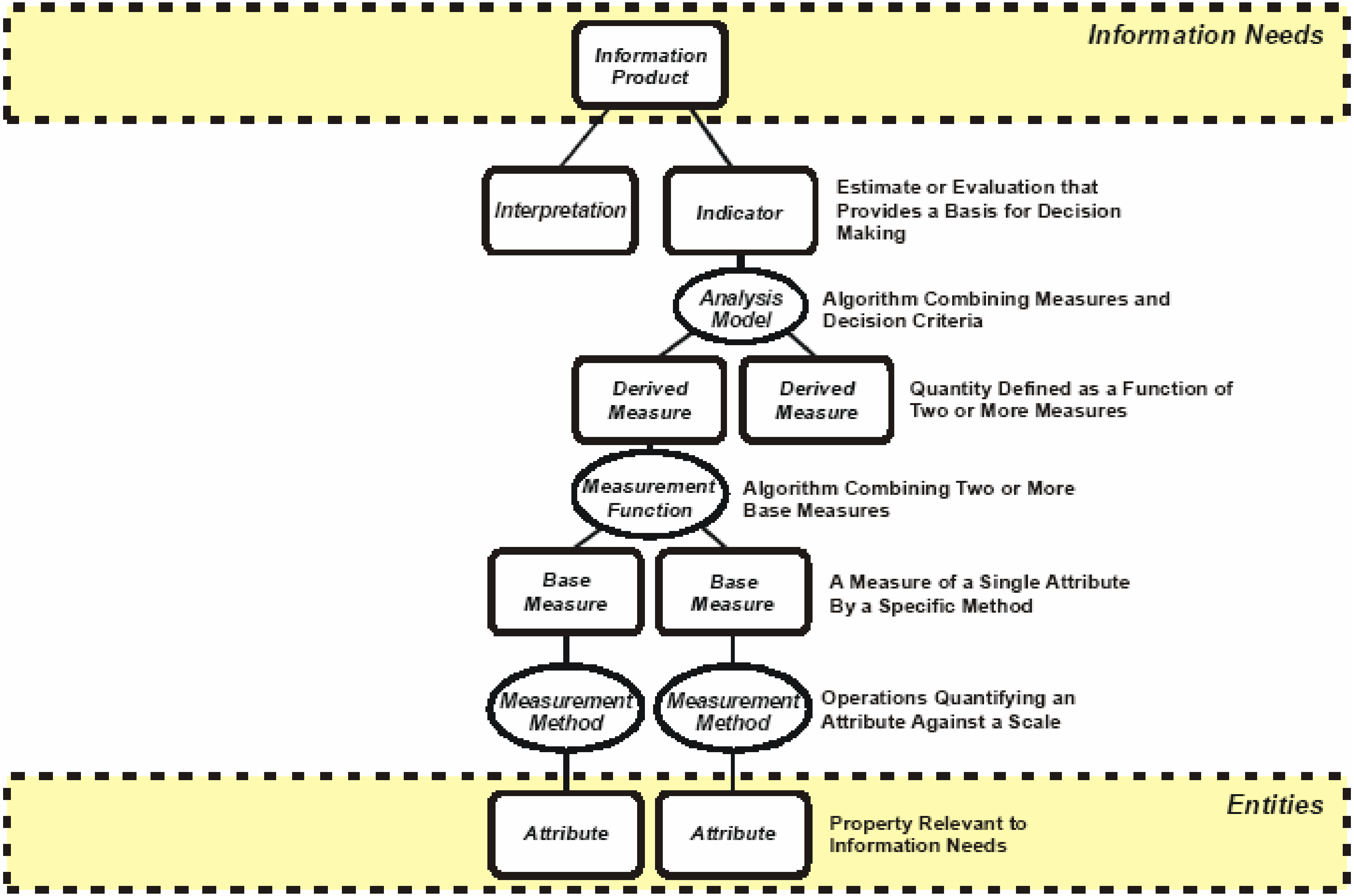
ISO/IEC 15 3 , Software Engineering - Software Measurement Process



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CMMI

Measurement and Analysis Goal 1

Goal/Practices	Notes	Typical Evidence
SG 1 Align Measurement and Analysis Activities Measurement objectives and activities are aligned with identified information needs and objectives.	Focus is on alignment with objectives, not just specifying a set of metrics	
SP 1.1 Establish Measurement Objectives Establish and maintain measurement objectives that are derived from identified information needs and objectives.	See following slide	Information needs Measurement objectives
SP 1.2 Specify Measures Specify measures to address the measurement objectives.		List of metrics, operational definitions
SP 1.3 Specify Data Collection and Storage Procedures Specify how measurement data will be obtained and stored.		Collection and storage procedures
SP 1.4 Specify Analysis Procedures Specify how measurement data will be analyzed and reported.		Analysis procedures

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Information Needs & Measurement Objectives

- **Information needs** set requirements for determining the needed metrics
- **Measurement objectives** set requirements for determining the needed metrics collection, storage, analysis, and reporting mechanisms

Information Needs

What types of information are needed by the project?

- **Progress**
- **Quality**
- **Information needed by the organization**
- **Information needed by the customer**

Measurement Objectives

What objectives influence how the measures are collected, analyzed, stored, reported?

- **Accuracy**
- **Timeliness**
- **Security**

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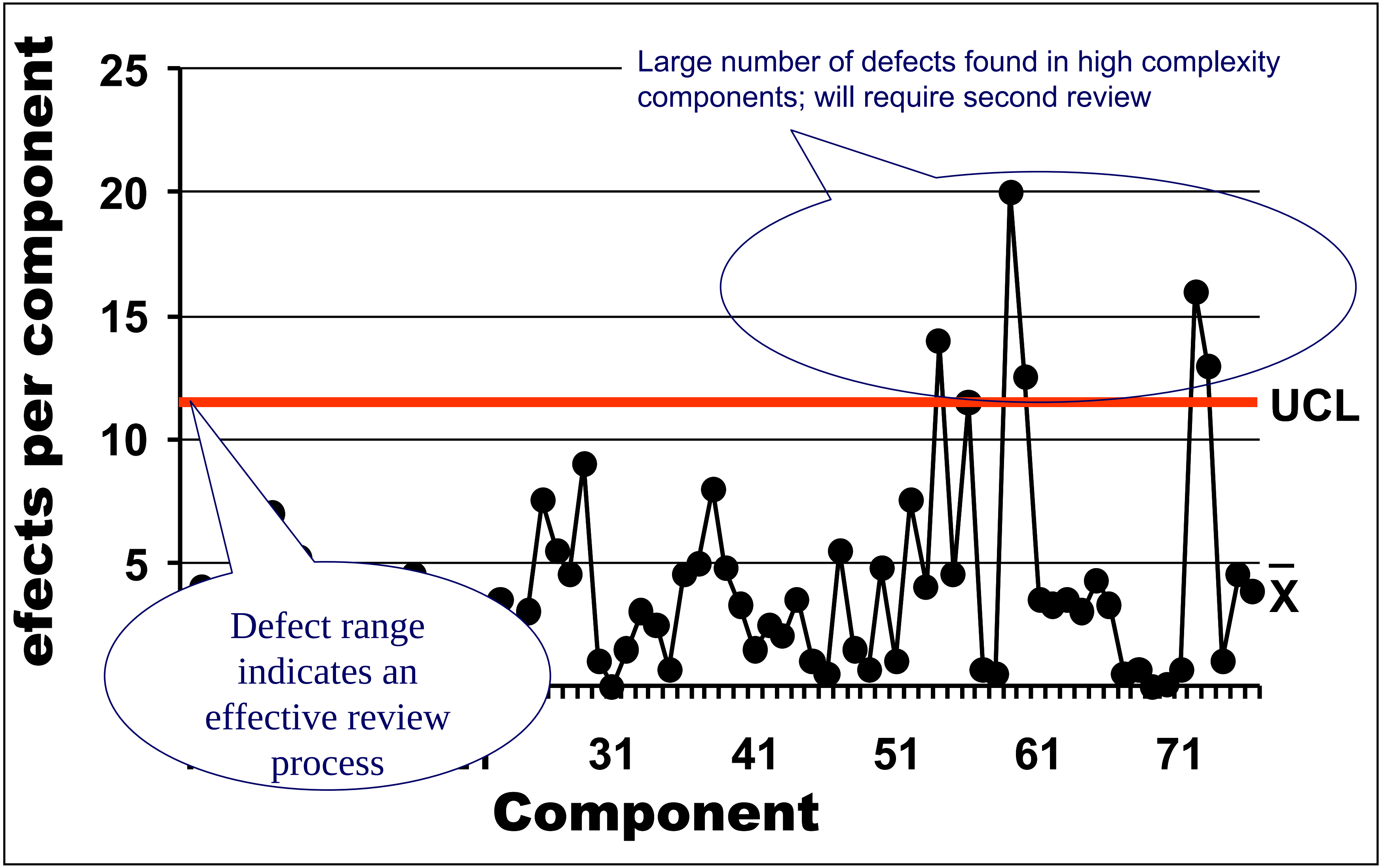
Measurement and Analysis   Goal 2

Goal/Practices	Notes	Typical Evidence
SG 2 Provide Measurement Results Measurement results that address identified information needs and objectives are provided.	Following defined procedures	
SP 2.1 Collect Measurement Data Obtain specified measurement data.		Measurement collection records
SP 2.2 Analyze Measurement Data Analyze and interpret measurement data.	Evidence should explicitly show interpretations	Analysis results Interpretations
SP 2.3 Store Data and Results Manage and store measurement data, measurement specifications, and analysis results.		Data storage records
SP 2.4 Communicate Results Report results of measurement and analysis activities to all relevant stakeholders.		Metrics reports/ briefings

What Does the Data Mean?



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Management Styles in the CMMI

Project

Quantitative management

Proactive management

Reactive mgmt. (plan, track, and correct)

Level	Process Areas
5 Optimizing	Causal Analysis and Resolution Organizational Innovation and Deployment
4 Quantitatively Managed	Quantitative Project Management Organizational Process Performance
3 Defined	Requirements Development Technical Solution Product Integration Verification Validation Organizational Process Focus Organizational Process Definition Organizational Training Risk Management Integrated Project Management (for IPPD*) Integrated Teaming* Integrated Supplier Management** Decision Analysis and Resolution Organizational Environment for Integration*
2 Managed	Requirements Management Project Planning Project Monitoring and Control Supplier Agreement Management Measurement and Analysis Process and Product Quality Assurance Configuration Management
1 Performed	

Organizational

Quantitative improvement

Qualitative improvement

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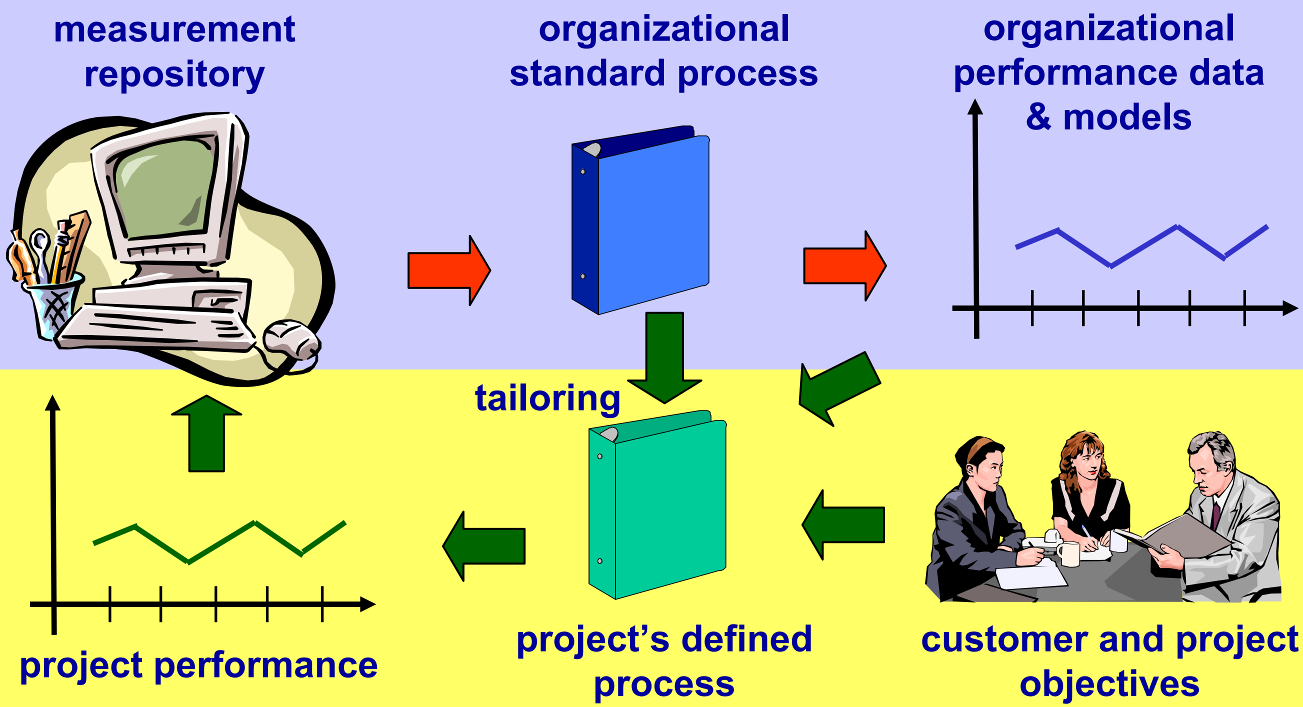
Measurement at CMMI Level

- **Organizational Process Performance**
  - Establishes a quantitative understanding of the performance of the organization’s set of standard processes
  - Provides process performance data, baselines, and models to quantitatively manage the organization’s projects

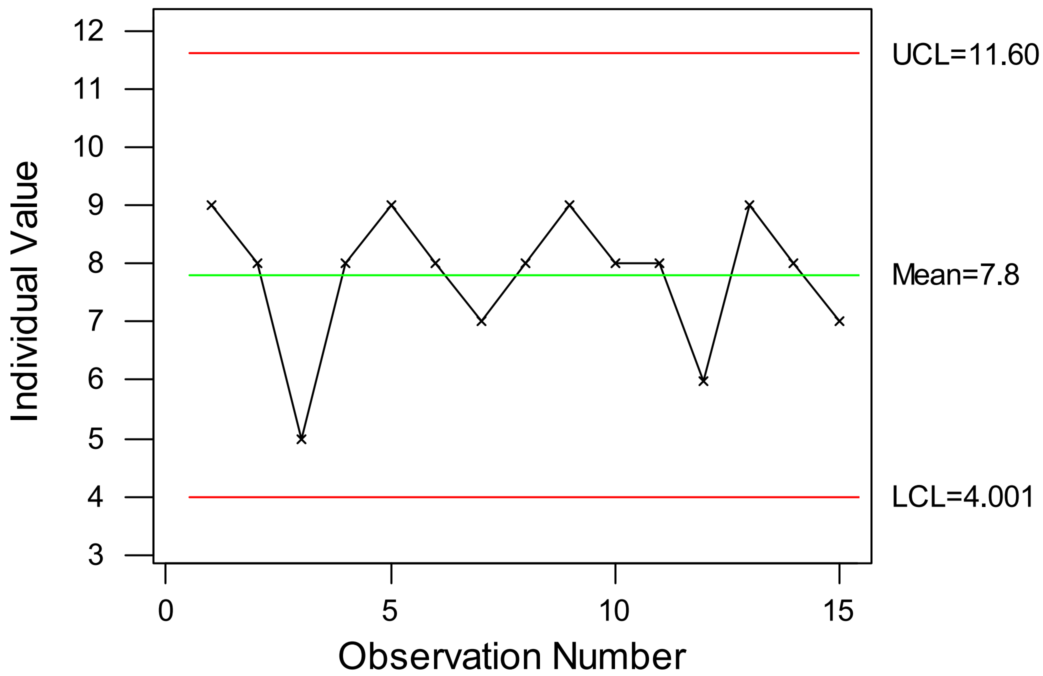


- **Quantitative Project Management**
  - Quantitatively manage the project’s defined process to achieve the project’s established quality and process-performance objectives.

Exercise

What is Quantitative Management?

- **Suppose your project conducted several peer reviews of similar code, and analyzed the results**
  - Mean = 7.8 defects/KSLOC
  - +3σ = 11.60 defects/KSLOC
  - -3σ = 4.001 defects/KSLOC



- **What would you expect the next peer review to produce in terms of defects/ KSLOC?**
- **What would you think if a review resulted in 10 defects/KSLOC?**
- **3 defects/KSLOC?**

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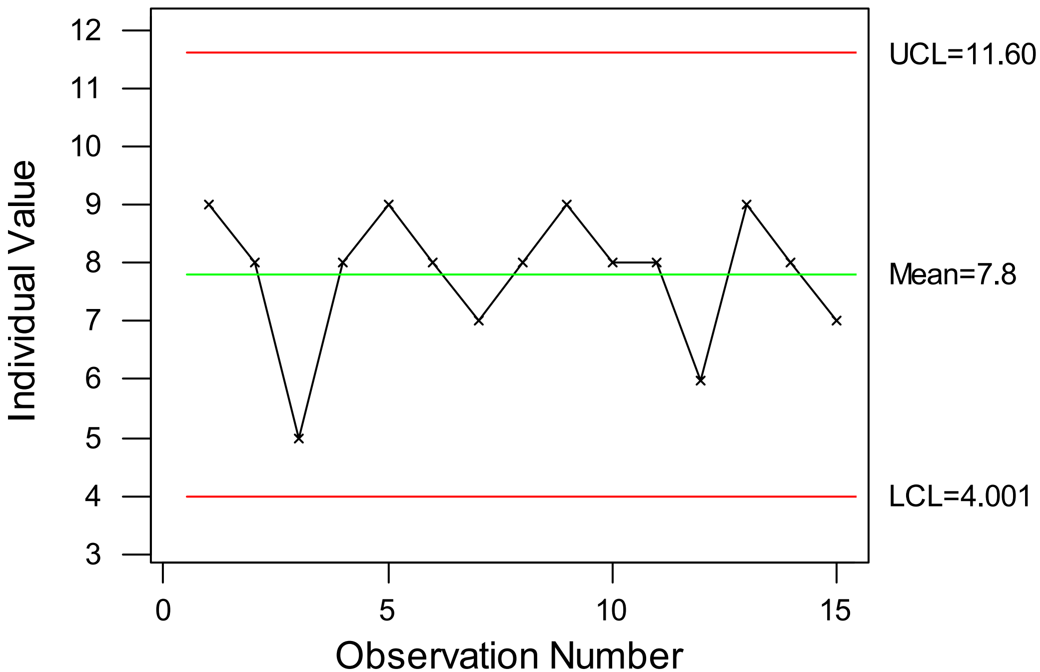
Exercise

What is Required for Quantitative Management?

- **What is needed to develop the statistical characterization of a process?**



- **The process has to be stable (predictable)**
  - Process must be consistently performed
  - Complex processes may need to be stratified (separated into simpler processes)
- **There has to be enough data points to statistically characterize the process**
  - Processes must occur frequently within a similar context (project or organization)

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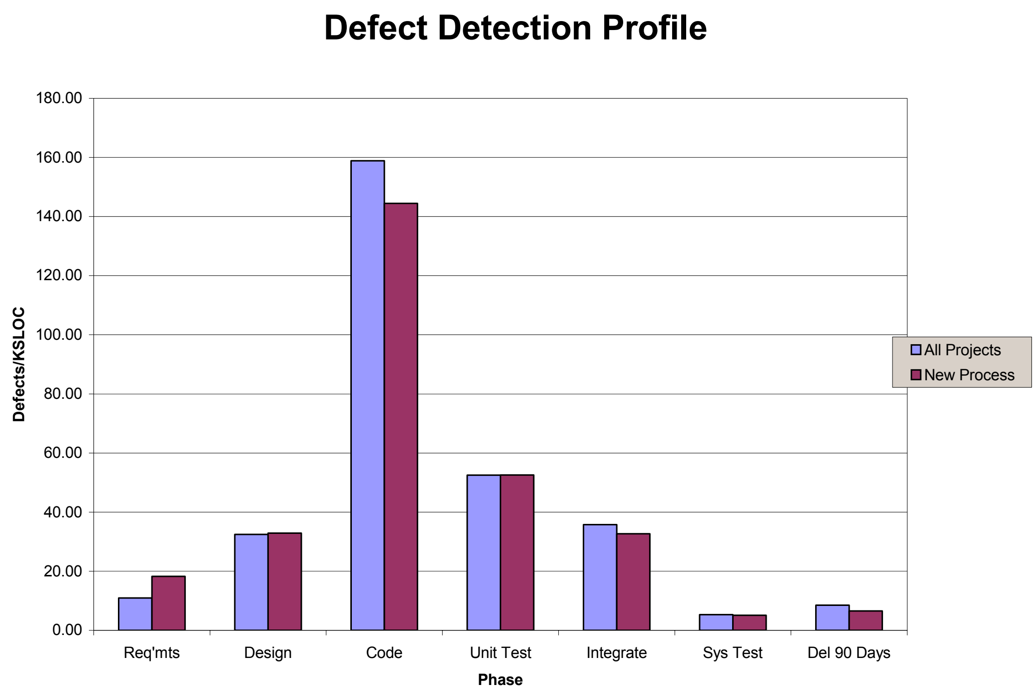
Typical Choices in Industry

- **Most customers care about:**
  - Delivered defects
  - Cost and schedule
- **So organizations try to predict:**
  - Defects found throughout the lifecycle
  - Effectiveness of peer reviews, testing
  - Cost achieved/actual (Cost Performance Index – CPI)
  - Schedule achieved/actual (Schedule Performance Index – SPI)



Process performance

- **Process measures** (e.g., effectiveness, efficiency, speed)
- **Product measures** (e.g., quality, defect density).

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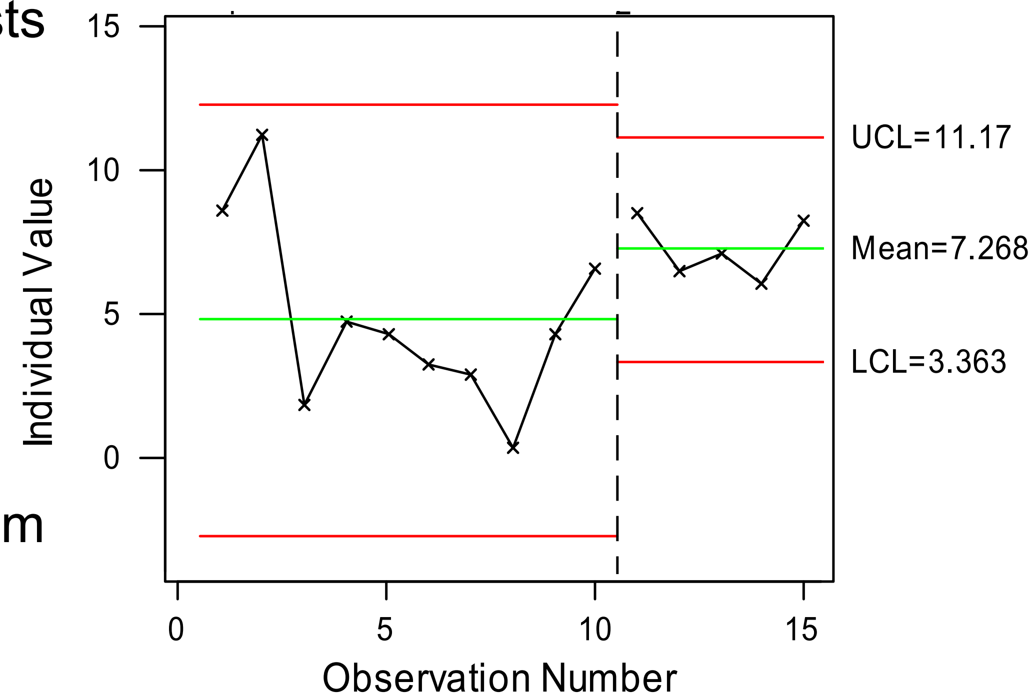
Measurement at CMMI Level 5

- **Organizational Innovation & Deployment**
  - Set quantitative improvement goals (e.g., reduce variation by X%, reduce mean by Y%)
  - Seek innovative improvements - cause a shift in process capability
  - Analyze potential improvements to estimate costs and impacts (benefits)
  - Pilot improvements to ensure success
  - Measure the impact of improvements quantitatively (variation and mean)
- **Causal Analysis & Resolution**
  - Identify and analyze causes of defects and other problems
  - Take specific actions to remove the causes - prevent the occurrence of those types of defects and problems in the future

Peer Reviews Improving the Process

- **Reduce the variation**
  - Train people on the process
  - Create procedures/checklists
  - Strengthen process audits
- **Increase the effectiveness (increase the mean)**
  - Train people
  - Create checklists
  - Reduce waste and re-work
  - Replicate best practices from other projects



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Lessons Learned

- **To establish (revitalize) a measurement system, start by identifying all the stakeholders and what information they need to make decisions**
  - Look for common needs, which drive common metrics that can be used by many stakeholders
  - There is no "magic" set of metrics that works for every project or every organization
- **It takes several months, if not years, to develop an effective measurement system**
  - Initially, focus is on ensuring data is provided
  - Next, focus in on data definition problems
  - Finally, focus on effective use of the data
  - Concentrate on developing a data-driven culture
- **When moving to Levels 4 and 5, expect a period of trial-and-error to discover the metrics you need**
  - Focus on management by variation (e.g., Six Sigma)

Integrated System Diagnostics INCORPORATED

Experiences Implementing Very Large, High Confidence Enterprise Appraisals

Paul D. Byrnes
Principal and CTO

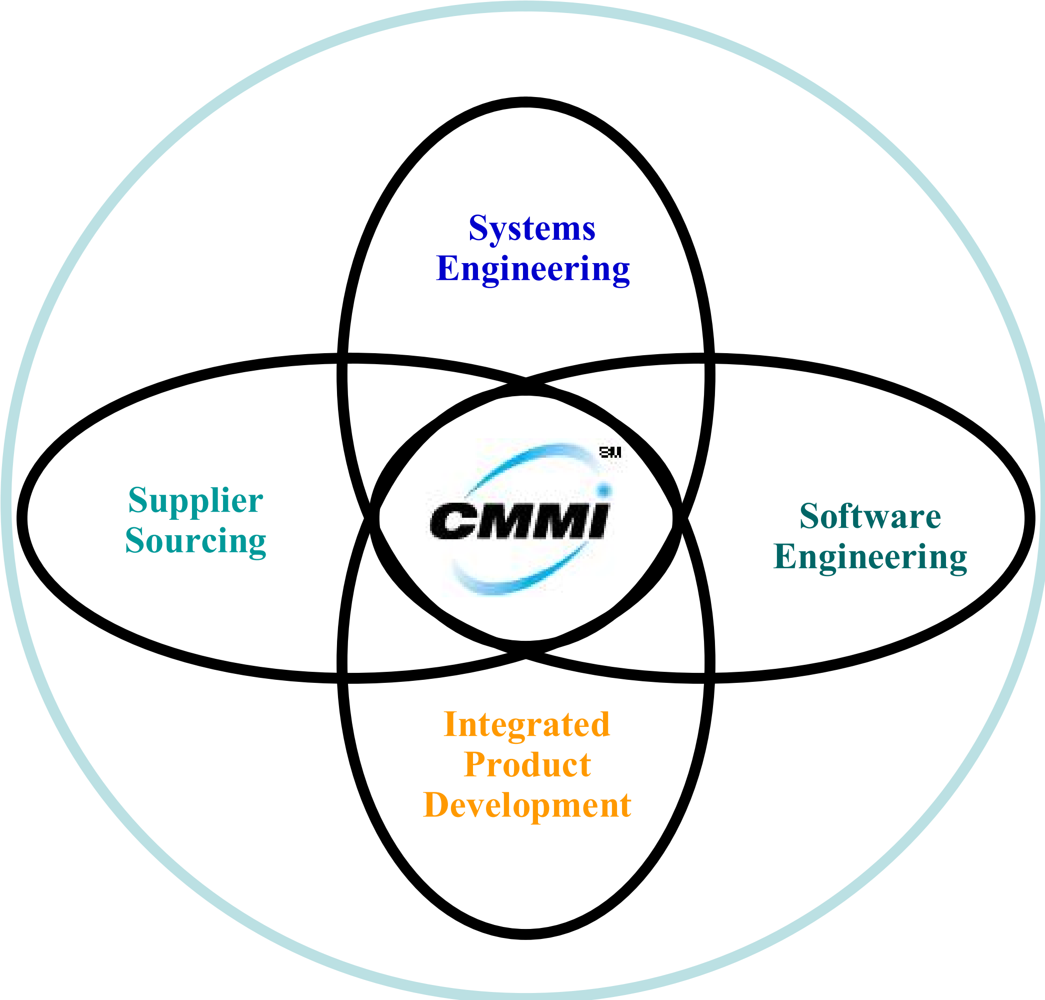
Presented at
CMMI Conference
November 15, 2007

Scope of Events Discussed

- 3 *very* large organizations in last three years

- SE/SW
- SW only
- SE/SW/IPPD

- Wide array of types of work. 2 Global, 1 U.S. Fed and State. 2 did not have external customer CMMI Level requirements. All deal with multiple frameworks. 1 has been doing CMM based improvement for a many years.



What is an Enterprise Appraisal?

- An event(s) that leads to a ratable Class A benchmark appraisal that includes multiple sub-units which in and of themselves are ratable OUs.
  - Includes more than one sub unit.
  - Includes corporate level organization units (above the typical OU scope)
- Why?
  - Confirm standard process roll out and execution
  - Gain competitive advantages
  - Accept and work with reality of constant organizational changes
- **Is it one "big honking appraisal?" – No!!**

Stakeholder Concerns to Address

- Senior sponsor: ñIs this going to bust our budgets? Whatôs the benefit?ò
- Business Unit sponsor: ñI donôt want to jeopardize *my* bonus!ò
- Program Managers: ñWhy do I care about these *other* business units?ò
- EPG members: ñHow can I support all these events and help people improve too!ò
- Enterprise Lead Appraiser: ñHow do I ensure that all these appraisals are run effectively ï I canôt be on them all!ò
- Lead Appraisers: ñI donôt want *my* appraisal at risk with SEI by doing some non-standard eventé !ò
- SEI: ñWe donôt want any SCAMPI principles violated ot requirements missed, and we donôt want organizations making crazy level claims!ò

Several Innovations and Improvements

- Org (enterprise level) appraisal elements
- Incremental Data Reuse
- Org Sampling criteria
- PIID Refresh events (practice sampling)
- Verification Reviews

- Strategic Appraisal Plan
- Central Appraisal Planning
- Implementation ñWavesò
- Common tooling (and work instructions)
- Common training
- Common Interpretations
- Norming with Leads

We will discuss these bullets throughout the presentation

Appraisal Goals ï Enterprise Impacts

Common Goal	Sub-Goal	Enterprise Appraisal Implementation
Ensure results	Contribute directly to business improvement Comparable across companies/organizations	Increased *specificity* needed Comparability *required* Customer *“believability”* essential
Optimize value to sponsors	Support business objectives Optimize cost and minimize disruption	*Multiple* requirements must be satisfied Enterprise *“big picture”* focus
Ensure appraisal reliability	Create repeatable processes ï standardize Make results predictable and differences explainable Results independent of team composition	*Objectivity* essential Use of external (non-OU) resources increases *Standardization* needed.

Slide adapted and updated from presentations by Mr. Byrnes while managing the appraisal project at the SEI.

Appraisal Goals ï Business Unit SCAMPIs

- Provide a thorough, objective benchmark against the CMMI
- Baseline the process capability of each targeted business unit against the CMMI V1.1, Staged Representation, using the SCAMPI V1.1 method
- **Ensure events are led, managed, and executed in a manner that is**
  - **ARC *compliant*,**
  - **fully *defensible*, and**
  - **results are *acceptable* to respective clients requiring reference model benchmarks.**
- **Ensure each entity receives appraisal assets that are *usable* by the business unit sponsor *independent* of any final Enterprise ML rating**
- Receive an official CMMI Maturity Level Rating from a team led by an external SEI Authorized SCAMPI Lead Appraiser
- Conduct each appraisal within schedules tailored in each appraisal plan to meet overall Enterprise *and* Business Unit specific appraisal objectives.

el Scope ï Enterprise ORG

Level	Focus	Process Areas
5 Optimizing	*Continuous Process Improvement*	Organizational Innovation and Deployment Causal Analysis and Resolution
4 Quantitatively Managed	*Quantitative Management*	Organizational Process Performance Quantitative Project Management
3 Defined	*Process Standardization*	Requirements Development Technical Solution Product Integration Verification Validation Organizational Process Focus Organizational Process Definition Organizational Training Integrated Project Management Risk Management Decision Analysis and Resolution
2 Managed	*Basic Project Management*	Requirements Management Project Planning Project Monitoring and Control Supplier Agreement Management Measurement and Analysis Process and Product Quality Assurance Configuration Management
1 Initial		

Quality and Efficiency are increased

Risk and Rework are Reduced

Enterprise level entities reviewed separately or in conjunction with underlying unit Class A events.

Reference Model Scope ï Overall

Target Process Capability	Rating Baseline	Rating Elements	Other
(For each sub-unit SCAMPI) CMMI v1.1 Levels x and y, Staged Representation	Full Scope, Full Coverage with formal ratings of all Level x and y PAs Maturity Level rating required Joint ISD/client team	Maturity Level Process Areas Process Area Goals Generic practices Specific practices	Results of underlying business unit benchmark Class A appraisals and the Enterprise level risk appraisal (Class B) event and document review performed during the Readiness Review may be re-used, as applicable, within the teamõs appraisal database.
(For enterprise event) CMMI v1.1 Staged Representation, Organization process areas	Full coverage with process area ratings for Organization level Process Areas (OPD, OPF, OT, OEI)	Process Areas Process Area Goals Generic practices Specific practices	A sampling of practice implementation across prior appraised units will be re-validated as part of the Enterprise appraisal to ensure continued institutionalization of sub unit ratings [called PIID refresh events].
(For each sub-unit SCAMPI) (For enterprise event) CMMI v1.1, Staged	None	None	Resulting appraisal artifacts from underlying SCAMPI Class A predecessor events will be verified by the Enterprise Lead Appraiser for ARC compliance.

Data reuse

Practice Sampling

Asset Verification

Org Scope ï 3 Primary Event Types

Company	Business Unit	Location	Site visit dates
<Very Large Company X>	<Named> Sector <Named> Organizational Units	Multiple locations throughout the United States.	Multiple throughout <several years> **Many sub unit Class A's**
<Very Large Company X>	<Enterprise Organization entity>	<On site City, State>	<on site peric **Enterprise Level "O" appraisal**
<Very Large Company X>	<Named> Sector Some <Named> Organizational Units [PIID refresh events]	Varied	<On Site Period> and other dates within 3 months of enterprise SCAMPI **PIID Refresh events**

Organization Scope ï Enterprise SCAMPI

For the enterprise level SCAMPI, the Organizational infrastructure entities appraised in entirety or in part:

- Senior Leadership
- Enterprise Process Group (EPG)
- Quality Management and Delivery Assurance
- Human Resources
- Organizational Training
- Knowledge Management (infrastructure and tools)

Entities in large organizations typically above the division level that create, deploy, and maintain common assets across the whole enterprise.

Enterprise Appraisal Results

- The *Enterprise* SCAMPI Class A event results in
  - Process Area ratings for OPF, OPD, and OT for organization entities
  - An *overall* Enterprise Maturity Level rating based on the *combined* results of the Enterprise SCAMPI and the results of each underlying Wave 1 Business Unit SCAMPI Class A.

- The Enterprise SCAMPI Class A event does ***not*** re-benchmark underlying business unit SCAMPI results.
  - Each sub-unit has been rated *separately* with full coverage and its own ADS
  - Where appropriate (ratings outside 90 day Enterprise event window), PIID Refresh events are conducted to *confirm capabilities* are still in place.
  - Business Unit Class A appraisal assets and results are *verified* to ensure *adequacy*, *completeness*, and ARC *compliance*.

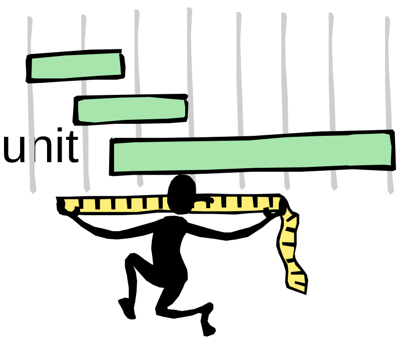
Appraisal Considerations

Appraisal practices (examples)	Implementation issues, risks, and recommendations	Appraisal considerations
Plan the Process (GP 2.2)	Organizations often donꞌt know how much data is needed relative to prior events when increasing scope.	Must engage outside Lead sooner. Do Central Appraisal Planning. Sampling strategies need to be documented. Align goals across units, not just within. Use historical appraisal data for estimating.
Identify and Involve Stakeholders (GP 2.7)	Very broad set of stakeholders. Easy to miss key people. May involve groups not previously part of appraisals.	When ñnewò groups involved, they exhibit ñlow appraisal maturityò despite organization overall process capability. More prep time needed. Do training even if they already had it.
Establish a Defined Process (GP 3.1)	Organizations often focus on procedures *within* processes, rather than with interfaces, coordination, synergy, and integration across.	Need documents that describe connections across process elements and organizational boundaries.
Review Status with Higher Level Management (GP 2.10)	Many issues and decisions can be driven down to lower levels appraisals.	Manage the effort like a project. Decompose the problem. Track metrics. Set norms up front.
Manage Configurations (GP 2.6)	Data across company in multiple repositories. Significant IT, security and archival concerns and needs.	Need for good CM to manage incremental appraisal database build up and reuse over several events. IT infrastructure critical.

Addressing Risks

Risk	Factors	Actions
Maintaining senior mgt. commitment	Caused by turnover or mergers Caused by management changes Issues resulting from shifting investment priorities	Dual or tri-sponsorship for major events ï enterprise, EPG, Business Unit ï interfaces established
Middle mgt. resistance	Overriding pressure for project performance; Incentives on delivery, not quality Focus on Level rather than improvement	Assign EPG TPOCs for each unit. Minimize disruption.
Inappropriate or conflicting goals	Focus on Level rather than improvement Business Unit Level x goal, Enterprise level y goal	Ensure each major sub unit is intervened with. Tailor events ï not force single approach.
Unrealistic expectations	All OUôs benchmarked by year end in the 4th quarter. Start Up projects Level x by year end.	Spread events over long period. Establish incremental strategy and roll up. Define ñwave strategy.
Crash implementations	PIID mania. Big bang appraisals. Process in a box.	Lots of efforts on going at any one time. Not one ñmegaò effort. Several methods in tool kit.

Risk Management Activities



- Spend extra time up front defining the organization scope, strategy, approach, and techniques. How much time? Years! *(this is not a tactical effort!)*

- Integrate outcomes from a series of events for each business unit (swim lanes). Affinitize units into ñwaves,ò for deployment and benchmarking. *(this is practical!)*

- Standardize appraisal assets for use by a commonly trained set of appraisers, using a central appraisal planner. *(these are essential and sometimes learned after the fact!)*

- Norm the set of Leads ï each Leadôs ways of doing business on a one-off needed to adjust slightly. *(this is challenging!)*

- Involve the SEI throughout, at key pivot points *(this was hard!)*

Example Appraisal Team Set Up

Appraisal Event	Team Size	Days on site	Team Comp.: External – External to OU – Internal to OU	Effort hours /Team Member (normative)	Trends
Class A	6-8	5-7	At least 2 totally external, ½ non OU	45	↓
Class B	6-8	7-10	Tried to have same team as A	64	↑
Class C	1-3	3-5	Usually internal or expert driven	24	
Readiness Review	4 or more	5	½-1.0 size of A	40	↑
PIID Refresh	4	3-4	½ the size of A; all from A team	24	↓

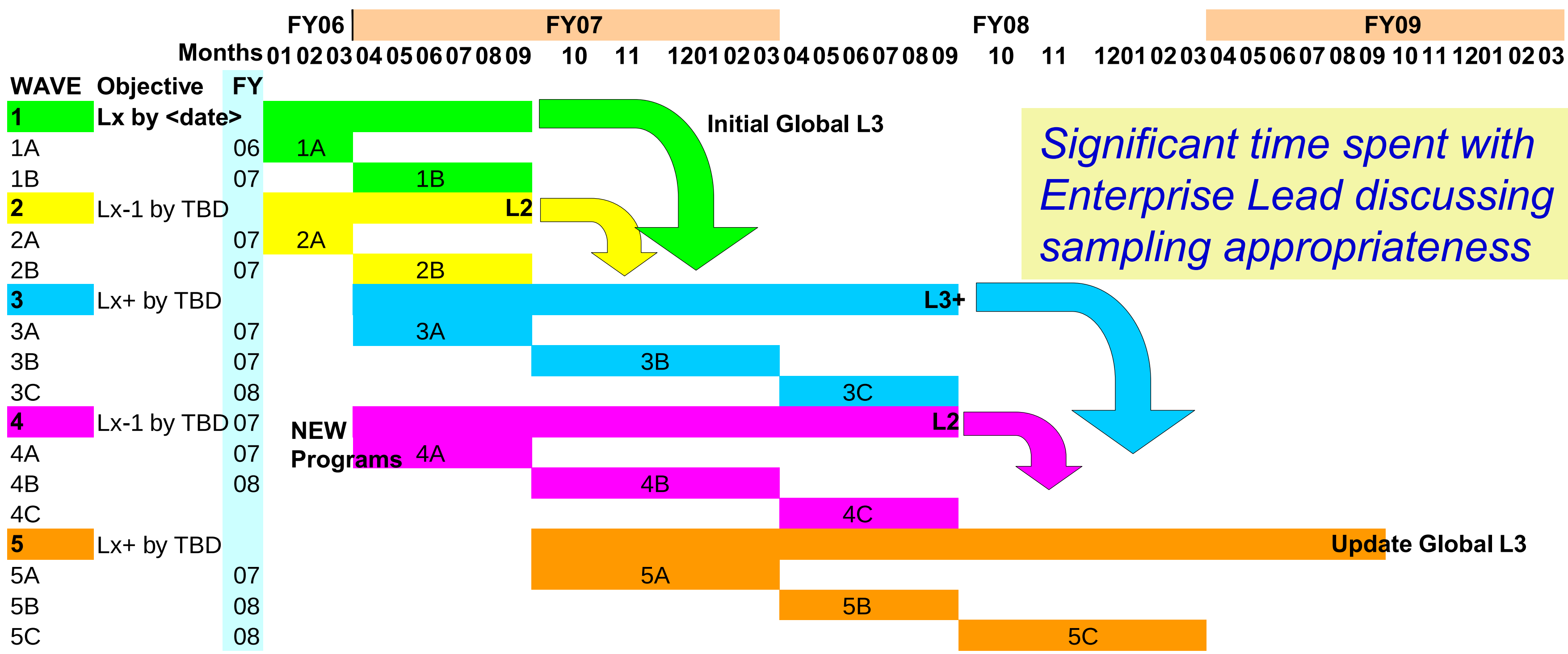
Whatôs a Wave?

- Due to size and complexity of the organization, processes and process improvement activities can be deployed in ñwaves.ò
  - Mechanism to prioritize EPG involvement
  - Mechanism to focus organization improvement where end customer or project specific needs are most pressing
  - Establishes and exceeds reasonable percentages for organization coverage for enterprise and separate business unit ratings
  - Accounts for reality that not all programs will be at same maturity state at same time
  - Ensures process deployment across entire Enterprise
  - Reduce risk, increase success rate, manage complexity

- Assumption: Not all units targeted will be at the same stage of maturity, or readiness for change, or ability to implement changes.

just the high level flow – there was much more detail

Conceptual Diagram ï Deployment ñWavesò



Notional timing for discussion and illustration purposes only

Whatôs a PIID Refresh Event?

- Purpose: Verify process still in place and implemented for a previously benchmarked unit.

- Need: Canôt realistically perform all required Class A events in a 90 day pre-Enterprise Class A window due to
  - Business unit specific needs and objectives
  - Resource constraints
  - Practical project work flow issues

- Timing: performed within 90 day window of Enterprise Class A

- Timing criteria relative to last successful Class A benchmark
  - 0-3 months: use underlying data as is ï full reuse
  - 4-12 months: do PIID refresh to confirm current status
  - >12 months: do full Class A event

is is just the high level criteria – there was much more

PIID Refresh Guidelines/Criteria

Environmental Attribute	Current State Relative to Benchmark Event	Risk to Incremental Appraisal Outcomes	Risk Mitigation Activities
Major re-organizations	None/List specific change, date, and impact	Low/Medium/High	<Describe actions taken>
Major acquisitions			
Major changes in standard process			
Significant changes in plans/scope of appraised projects			
Senior Management changes			
Organization restructuring			
Process implementation changes			

was an entire Appendix and an embedded document Strategic Appraisal Plan dedicated to this topic.

Whatôs a Practice Sampling Plan?

- Purpose: Tailor follow on appraisal event to minimize cost and disruption on an organization that has already successfully executed a full Class A but must participate in the Enterprise event.

- Approach: Obtain maximum *actual* OE coverage through optimizing a tailored set of practices reviewed. Pick ñheavy hitterò and ñrepetitiveò practices. Use precedence and dependency relationships inherent in the model. Example:

Level	Process Area	Goal	Practice	EL	OU	Decision Criteria Rationale
2	REQM		SP 1.3 SP 1.5 GP 2.6 GP 2.8	X	X X X	Need to be able to manage changes and reconcile project issues as they change and ensure all relevant assets are getting updated. Making sure controlling requirements key. Ensure Org level is collecting requirements metrics.
2	PP		SP 1.2 SP 2.7 SP 3.2 GP 2.6 GP 2.2	X	X X X X	Estimates always an issue. Plan updates affect everything else and will see the other goal 2 practices. Reconciling tasks/resources always an on-going challenge. Controlling changes to plans, estimates, etc. tends to be a typical issue area. Ensure org level is getting plans from programs

Whatôs an Asset Verification Review?

- Purpose: Ensure all underlying events leading to the Enterprise SCAMPI Class A event were performed with high quality and in accordance with all SCAMPI requirements.

- Approach: Develop and use a standard appraisal requirements checklist to perform reviews of all key appraisal deliverables for each event
  - Plans, briefings, reports, ADS, etc.
  - Document issues, recommendations and gaps as ñfindingsò for corrective action.
  - Issues in underlying events could potentially delay the final Enterprise outcome

Class A Requirements Checklist - Sample

Activity	Task	Requirements	Verification Notes	Verified
Analyze Requirements	Determine Appraisal Objectives	Identify Sponsor and Relevant Stakeholders	In Strategic Appraisal Plan Section 2.0	z
		Document Business and Appraisal Objectives	In Strategic Appraisal Plan Sectio[illegible]	
		Ensure Alignment of Appraisal Objectives with Business Objectives	In Strategic Appraisal Plan Section 3.0 and in Team In Brief and Organization In Brief	z
		Determine and Document Appraisal Usage Mode	In Strategic Appraisal Plan throughout and in Team In Brief	z

Objective Evidence Challenges

- Need common rules and guidance as to instantiations required.
- Need work instructions on
  - how to present data,
  - how much data is needed, and
  - how the team is to record its review of the data.

- Need for automated tools increased ï expansion in data elements, data reuse strategy, merging of data increases *need for different approaches to recording data*
- Organization Coverage: large units have a real challenge of showing institutionalization across the entity when only reviewing a small set of projects in a Class A ï *how many instances is enough? What percentage of the unit is enough?*
- Functional Coverage: *there may be "org" groups that need to be covered at multiple layers of the overall enterprise (corporate, division, business unit).*

Model Interpretation Issues

- What is the ñorgòfor OPD, OPF, and OT purposes?
- What makes up the ñratableòmetrics repository?
- How ñconnectedòmust the enterprise be to the units? And vice versa?
- Team needs ability to ñintegrateòrather than de-compose [holistic perspective] for the Enterprise event.

Some Pitfalls and Take Aways

- Pitfalls
  - Donȇ assume everyone will understand on the first run.
  - All sub-units must buy into the approach as well, even if they have some specialized unit appraisal objectives.
  - Appraisal experience matters.
  - Team members that have worked with each other before matters.
  - Work instructions matter.
- Take Aways
  - Management support is *really* needed.
  - Communication vehicles *must* be routinely delivered.
  - Standard assets and common training *facilitate* easier comparisons.
  - Central planning helps ensure consistency
  - IT infrastructure for evidence collection, asset archive repository, and team activities is *essential*.

Key Organizational/Appraisal Challenges

- Organizational
  - Too many models. Too many methods.
  - Management drivers for *reduced* process improvement costs.
  - Need to *increase* efficiency of both internal improvement activities and external appraisal efforts.
  - Customer ñdisconnectsò between ñlevel achievementò and ñproject performance.ò

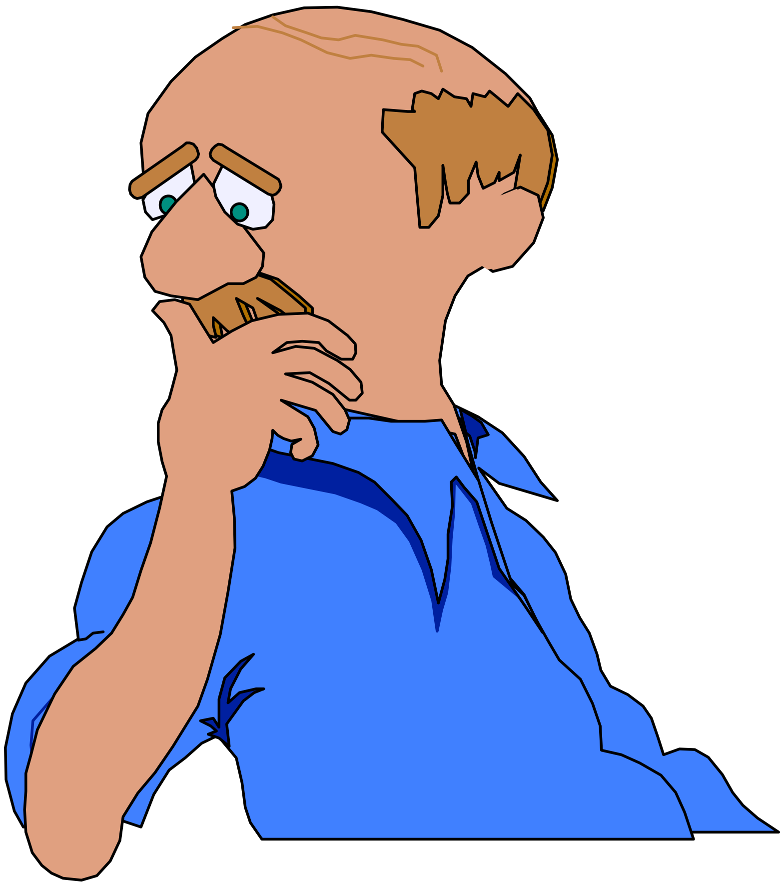
- Appraisal
  - Data element needs increase and morph with enterprise focus
  - Some SCAMPI rules can actually get in the way
  - Changes in method not fast enough to keep up with changes in organizational needs

Issues, Directions, and Opportunities

Issues	SCAMPI V1.2 still focused on “single point appraisals,” not set of integrated appraisals from an enterprise perspective
Directions	Starting second wave on 2 major accounts. Improvements in approach being documented now. Continue technical development
Opportunities	Technical approaches taken were considered a *great* success from all key stakeholders: Sponsors, EPG lead, Enterprise Lead Appraiser Interface with SEI for potential updates to SCAMPI

Questions and Answers

- Q
- &
- A



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DEFINING THE FUTURE

Judging the Suitability of Alternative Practices

CMMI Technology Conference & User Group
12-15 November 2007

Rick Hefner
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Background

**alternative practice - ** A practice that is a substitute for one or more generic or specific practices contained in CMMI models that achieves an equivalent effect toward satisfying the generic or specific goal associated with model practices. Alternative practices are not necessarily one-for-one replacements for the generic or specific practices.

-- Glossary, CMMI for Development Version 1.2

- **What does this mean?**
- **Under what conditions do alternative practices occur?**
- **How do you judge whether they are acceptable?**

Understanding the Context of the CMMI

- **context** – 1: the parts of a discourse that surround a word or passage and can throw light on its meaning; 2: the interrelated conditions in which something exists of occurs

  -- Merriam-Webster OnLine Dictionary

- **CMMI is a best practice model**
  - It reflects best practices that address development and maintenance activities applied to products and services
- **What is “best” in a given situation (i.e., a development activity) depends on the context**

Hefner and O'Toole, "Judging the Suitability of Alternative Practices", 2007

An Example of Context

- "You should not talk with your mouth full?"
- This is a best practice - a good general rule to be followed
- Are there contexts in which the rule doesn't apply? What if:

Your toddler is about to touch a hot stove?

You're demonstrating
why talking with your mouth full looks bad?

The culture considers talking with your mouth full proper and polite?

Hefner and O'Toole, "Judging the Suitability of Alternative Practices", 2007

How Does this Apply to CMMI?

The structure of the CMMI is:

- **Goals are appropriate in <u>any</u> context envisioned by the CMMI authors**
  - Hence, they are required;
- **Practices are appropriate in <u>most</u> contexts**
  - Hence, are expected
  - Alternative practices may be appropriate in the other contexts;
- **Subpractices, etc. are appropriate in <u>some</u> contexts**
  - Hence, are treated as informative
  - Because in many contexts they may not be appropriate.

Hefner and O'Toole, "Judging the Suitability of Alternative Practices", 2007

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What is the Context Assumed by the CMMI Authors?

- **There is no explicit statement of the assumed context (e.g., large DoD contractor, small commercial company, etc.) for any practice**
  - Each author was probably biased by the types of examples they had seen in their own organization
- **Also, the same context is not assumed for all informative material throughout the model**
  - Different authors, different times = different contexts
- **Hence, the informative material is simply one example of a myriad of ways that <u>might</u> be appropriate for meeting the practices, not the <u>only</u> way, or even a <u>preferred</u> way**

Hefner and O'Toole, "Judging the Suitability of Alternative Practices", 2007

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An Example Level /5

- **At the time CMMI was written, most industry examples were software organizations that repeatedly develop the same type of software**
  - Similar programming languages, similar applications, similar staff, similar project goals
- **Quite a different context than a geographically-distributed US DoD contractor with a wide dispersion of project types implementing a Six Sigma methodology**
- **Result -- Some informative material in QPM assumes projects quantitatively manage the same subprocesses quantitatively managed in OPP**

Hefner and O'Toole, "Judging the Suitability of Alternative Practices", 2007

The Definitions Provide Clues as to Context

- **project -** a managed set of interrelated resources which delivers one or more products to a customer or end user. A project has a definite beginning (i.e., project startup) and typically operates according to a plan… A project can be composed of projects.

- ***How does this definition fit your scope of work?***
  - *Contracts with many different deliverables*
  - *Programs composed of multiple projects*
  - *Maintenance work*
  - *Service projects*

Hefner and O'Toole, "Judging the Suitability of Alternative Practices", 2007

ATLAS 10 Survey Structure

- **Candidate alternative practices were solicited from the community at large; requested submission of either:**
  - Practices actually implemented; or
  - Ways of describing “alternative practices”
- **77 respondents - 44 unique candidates were submitted**
- **44 candidates consolidated into 11 groups of four**
- **Each group was distributed randomly to the SEI-authorized individuals**

Hefner and O'Toole, "Judging the Suitability of Alternative Practices", 2007

ATLAS 10 Question 1

Please select the letter that best represents your view of this candidate alternative practice

A. I strongly agree [that this an acceptable alternative practice]
B. I somewhat agree […]
C. I neither agree nor disagree […]
D. I somewhat disagree […]
E. I strongly disagree […]

- **Each response (A-E) for each candidate alternative practice was quantified as follows:**
  - A or B (I strongly/somewhat agree): +1 point
  - C (I neither agree nor disagree): 0 points
  - D or E (I somewhat/strongly disagree): - 1 point
- **A candidate alternative practice's "score" = the average across all respondents. For the 44 candidate alternative practices:**
  - Score Range: +0.59 to -0.85
  - Score Mean: -0.25
  - Score Median: -0.26

Hefner and O'Toole, "Judging the Suitability of Alternative Practices", 2007

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Example 1: SAM SP 1.2 (Score: 0.5)

SP 1.2 Select Suppliers
***Select suppliers based on an evaluation of their ability to meet the specified requirements and established criteria*.**

- **Rather than selecting a supplier, our org has the suppliers imposed by our primary customer.**
- **The ability of the supplier to meet the requirements is analyzed, and the results of this analysis are presented to the customer. If there are concerns about the supplier's ability to meet the specified requirements, risks are documented and shared with the customer, or managed internally by the org.**
- **Experience logs are maintained for each supplier to influence the customer's supplier selection in the future.**
- **The direct artifacts for this candidate alternative practice are the notification from the customer that we must use the designated supplier, the analysis report, and associated risks, and the experience logs maintained for each supplier.**

Hefner and O'Toole, "Judging the Suitability of Alternative Practices", 2007

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How Do We Determine Whether This is an Acceptable Alternative Practice?

**alternative practice - **A practice that is a substitute for one or more generic or specific practices contained in CMMI models that achieves an equivalent effect toward satisfying the generic or specific goal associated with model practices.

SP 1.2 Select Suppliers
***Select suppliers based on an evaluation of their ability to meet the specified requirements and established criteria*.**

SG 1 Establish Supplier Agreements
Agreements with the suppliers are established and maintained.

- **What effect are we trying to achieve?**
- **What would an equivalent effect?**

Hefner and O'Toole, "Judging the Suitability of Alternative Practices", 2007

Is the Informative Material Helpful in Judging Acceptability?

Criteria should be established to address factors that are important to the project.

Examples of factors include the following:

• Geographical location of the supplier

• Supplier's performance records on similar work

• Engineering capabilities

• Staff and facilities available to perform the work

• Prior experience in similar applications

Typical Work Products

1. Market studies

2. List of candidate suppliers

3. Preferred supplier list

4. Trade study or other record of evaluation criteria, advantages and disadvantages of candidate suppliers, and rationale for selection of suppliers

5. Solicitation materials and requirements

Subpractices

1. Establish and document criteria for evaluating potential suppliers.

2. Identify potential suppliers and distribute solicitation material and requirements to them.

A proactive manner of performing this activity is to conduct market research to identify potential sources of candidate products to be acquired, including candidates from suppliers of custom-made products and vendors of COTS products.

3. Evaluate proposals according to evaluation criteria.

4. Evaluate risks associated with each proposed supplier..

5. Evaluate proposed suppliers' ability to perform the work.

Examples of methods to evaluate the proposed supplier's ability to perform the work include the following:

• Evaluation of prior experience in similar applications

• Evaluation of prior performance on similar work

• Evaluation of management capabilities

• Capability evaluations

• Evaluation of staff available to perform the work

• Evaluation of available facilities and resources

• Evaluation of the project's ability to work with the proposed supplier

• Evaluation of the impact of candidate COTS products on the project's plan and commitments

When COTS products are being evaluated consider the following:

• Cost of the COTS products

• Cost and effort to incorporate the COTS products into the project

• Security requirements

• Benefits and impacts that may result from future product releases

Future releases of the COTS product may provide additional features that support planned or anticipated enhancements for the project, but may result in the supplier discontinuing support of its current release.

6. Select the supplier.

Hefner and O'Toole, "Judging the Suitability of Alternative Practices", 2007

So How Prevalent are Alternative Practices?

- **Only 5 of the 44 submitted candidates had more authorized individuals supporting the assertion that they were true alternative practices than refuting it**
  - That is, only 5 candidate alternative practices had a score > 0.
- **Given that 5 did pass a relatively simple litmus test, it may be concluded that "alternative practices" are REAL, and NOT merely conceptual!**
- **However, given that all 44 were submitted as viable candidates, it appears that "alternative practices" are not interpreted consistently across the population of authorized individuals**

Hefner and O'Toole, "Judging the Suitability of Alternative Practices", 2007

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ATLAS 10 Question 2

If you selected either D or E above (i.e., the candidate is unacceptable), please indicate your rationale:

A. The candidate is not sufficiently different from the model practice to be considered an "alternative"
B. Although an "alternative," it does not appear to support goal satisfaction as well as the practice as written
C. It is not acceptable because it eliminates the practice without providing a viable alternative
D. Other

- **Although most respondents that found a candidate alternative practice unacceptable did provide a response to Item #2, the choice (A – D) did not always align with the supporting comments**
- **Bottom line: Little useful insight was gleaned from analyzing the responses to Item #2**

Hefner and O'Toole, "Judging the Suitability of Alternative Practices", 2007

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ATLAS 10 Question 3

Regardless of its alternative practice candidacy, assuming that there are ample direct artifacts supporting consistent practice implementation on all projects as indicated, please provide your "gut-feel-characterization" for <practice> (considering the organization and projects as described).

_____ (FI, LI, PI, NI)

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ATLAS 10 Question 3 Responses

Some candidate alternative practices experienced significantly more variation than others

Candidate	FI	LI	PI	NI
4	3	2	2	1
10	2	3	3	0
12	6	1	4	0
13	5	2	4	0
14	2	2	1	2
19	2	1	1	3
24	3	2	3	3
27	5	1	3	3
28	7	1	4	1
32	2	2	1	2
34	4	1	5	0
25	4	2	4	1
26	6	1	2	3
44	9	1	4	2

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Hefner and O'Toole, "Judging the Suitability of Alternative Practices", 2007

Moving Forward

- **In the final analysis, alternative practices are rare**
  - The context assumed by the authors (and reviewers) is very broad, (e.g., small/big projects, small/big organizations, defense/ commercial, different business goals)
  - Many purported “alternative practices” are better described as “alternative implementations”
  - Some purported “alternative practice” can be an attempt to avoid changing an existing process
- **In identifying legitimate alternative practices, look for differences in the assumed context**
  - Definitions of “project”, “organization”, “customer”
  - Verbs which are not possible actions in your context, e.g., “select”
- **Even “experts” disagree about the acceptability of an alternative practice (or the adequacy of its implementation)**
  - Discuss all alternative practices with your Lead Appraiser <u>before</u> the appraisal

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Hefner and O'Toole, "Judging the Suitability of Alternative Practices", 2007

Example 2: PMC SP 1.7 (Score: 0.3)

SP 1.7 Conduct Milestone Reviews
Review the accomplishments and results of the project at selected project milestones.

- **Our org does not develop "traditional" projects but does maintenance work using time-boxing. Our management conducts monthly meetings with our customers to measure progress, assess risks and determine whether the features to be included in the next release are satisfactory or not.**

- **This is not a milestone meeting as it is not event-driven. Because of the large number of minor enhancement projects, it was decided that this was a better approach than trying to have "real" milestone meetings on every enhancement. There are typically 5-6 such monthly meetings per release.**

- **The direct artifacts for this candidate alternative practice are the minutes from the customer meetings as well as the documented issues and action items resulting from them.**

Hefner and O'Toole, "Judging the Suitability of Alternative Practices", 2007

Backup Slide

Example 3: CM SP 1.2 (Score: 0.25)

SP 1.2 Establish a Configuration Management System
Establish and maintain a configuration management and change management system for controlling work products.

- **We only have one customer for whom we develop and support software products. Our org is contractually required to use our customer's CM and change management control (CMC) systems. We have no need to establish and maintain a CM or CMC system of our own, and rely solely on our customer's systems to protect our configuration items and change requests.**
- **The direct artifacts for this candidate alternative practice are the customer's CM and CMC systems – and a demo of how we maintain our configuration items and change information using these systems.**

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Backup Slide

Example : VAL (Score: 0.25)

- **Our government customers require the system to be validated prior to acceptance. However, they require this to be done under their control using their validation environment, procedures, and users.**

- **Since we can't deem Validation to be "not applicable" and still be rated ML3, we have decided instead to treat this as an alternative practice.**

- **The direct artifacts for this alternative practice are the customer contract dictating how validation is to be performed, and the customer-run validation test results.**

Hefner and O'Toole, "Judging the Suitability of Alternative Practices", 2007

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DEFINING THE FUTURE

Cutting Appraisal Costs in Half

CMMI Technology Conference & User Group
12-15 November 2007

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Background

- **The SCAMPI method has significant flexibility and tailoring options**
- **Unfortunately, many Lead Appraisers do not take advantage of these options**
  - Some continue to conduct appraisals in the same style as the discovery-based CBA IPI methods used over 10 years ago
- **This presentation discusses the fundamental value-added steps of a SCAMPI appraisal, and how to tailor the methods to different organizational situations**
  - Preparation (scoping, planning, evidence gathering)
  - On-site (evidence review, interviews, consolidation)
  - Close-out (reporting, record keeping)

Hefner, "Cutting Appraisal Costs in Half", 2007

Topics

- Understanding the purpose of a SCAMPI appraisal
- Identifying the non-value added appraisal activities
- Scoping and planning the appraisal for minimum cost
- Tailoring choices, and how to make them
- Preparing the evidence
- Eliminating known time-wasters
- Being a smart buyer

Characteristics of CMMI Appraisal Classes

- **The ARC (Appraisal Requirements for CMMI) defines appraisal classes**
  - A guide to inventors of appraisal methods, and their customers
- **SCAMPI is a family of ARC-compliant methods**

***Appraisal Requirements for CMMI, Version 1.1**, CMU/SEI-2001-TR-034*

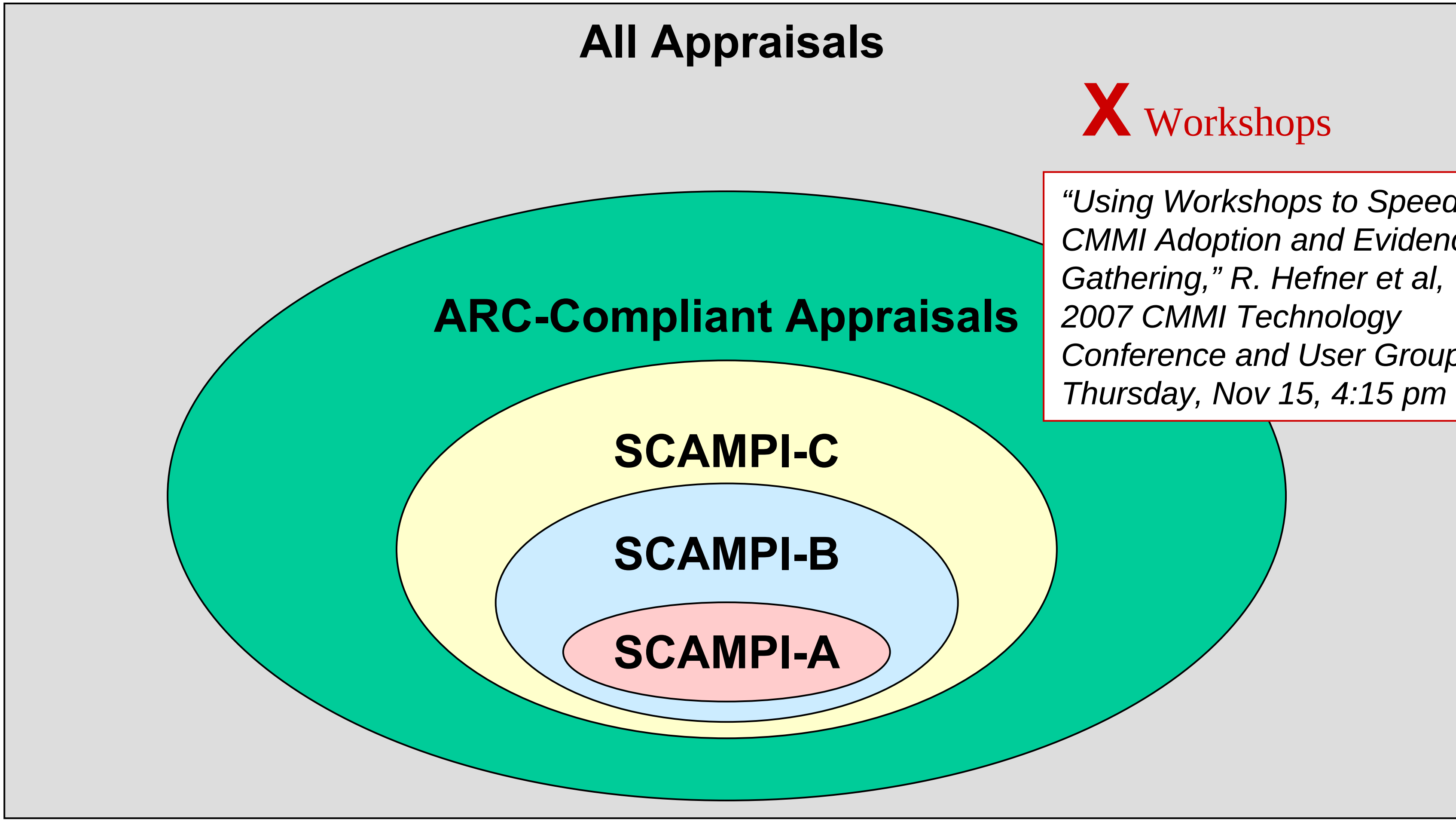
Characteristics	Class A	Class B	Class C
Amount of Objective Evidence Gathered (relative)	High	Medium	Low
Ratings Generated	Yes	No	No
Resource Needs (relative)	High	Medium	Low
Team Size (relative)	Large	Medium	Small
Appraisal Team Leader Requirements	Lead appraiser	Lead appraiser or person trained and experienced	Person trained and experienced

SCAMPI-A **SCAMPI-B** **SCAMPI-C**

"A Quantitative Comparison of SCAMPI A, B, and C," R. Hefner and D. Luttrell, CMMI Technology Conference and User Group, 2005

Hefner, "Cutting Appraisal Costs in Half", 2007

A Variety of Appraisals



"Using Workshops to Speed CMMI Adoption and Evidence Gathering," R. Hefner et al, 2007 CMMI Technology Conference and User Group, Thursday, Nov 15, 4:15 pm

"Lower Cost, More Effective Alternatives to SCAMPIs," R. Hefner, 2007 CMMI Technology Conference and User Group, Thursday, Nov 15, 3:30 pm

Hefner, "Cutting Appraisal Costs in Half", 2007

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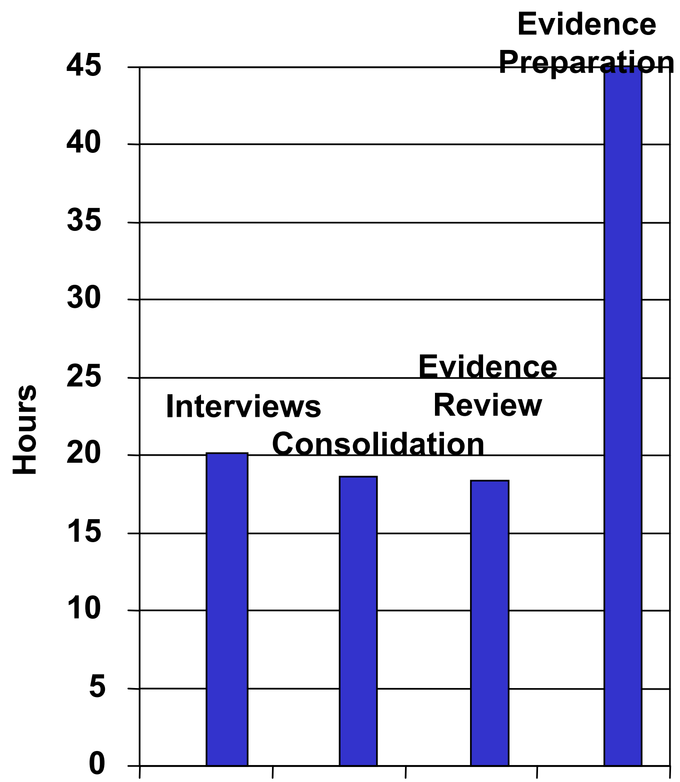
Applying Six Sigma To Appraisals

- **Several Six Sigma projects were conducted to optimize the SCAMPI appraisal process**



"Minimizing SCAMPI Costs via Quantitative Methods, " R. Hefner and Ron Ulrich, CMMI Technology Conference & User Group, 17-20 November 2003

- **Collected metrics on time spent on various appraisal activities, defects**
- **Used Pareto chart to identify bottlenecks, opportunities for improvement**
- **Used individuals charts to study variation in the appraisal process**
- **Used fishbone charts and other causal analysis methods to identify potential improvements**
- **Key considerations:**
  - Project preparation time
  - On-site appraisal time
  - Cost & resources
  - Accuracy of appraisal results

Hefner, "Cutting Appraisal Costs in Half", 2007

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Mapping the Process to Identify Bottlenecks

Suppliers	Inputs	Process	Outputs	Customers
Organizations	Assessment Schedules	**SCAMPI Appraisals**	Improvement Plan	Projects
Project Personnel	Project Evidence		Savings	Appraisal Teams
Lead Appraisers	Personnel Availability		Effective Appraisals	Organizations
	Project Schedules			Lead Appraisers

Process Steps

Site/Project Readiness → Team Training → Evidence Review → Interviews → Consolidation → Findings

Hefner, "Cutting Appraisal Costs in Half", 2007

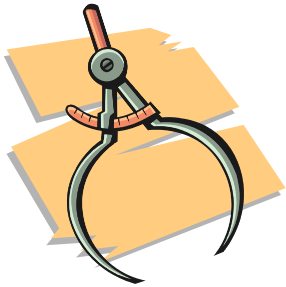
Techniques for Reducing Cost - Preparation

- **Scoping – Determining the portion of the organization to be appraised (the "organizational unit")**
  - Any logical portion of the organization may be chosen, e.g., a division, a site, a domain, etc.
  - The scope will impact both the utility of the appraisal results in marketing and the organizational buy-in
  - :"Cherry-picking" only part of the organization to be appraised may send the signal that CMMI is cost without value
- **Planning – Determining the budget, schedule, and logistics**
  - Highly driven by the approach to evidence review and interviewing
- **Evidence gathering – Compiling the direct and indirect evidence needed to provide compliance with the CMMI goals and practices**
  - Biggest preparation cost and effort
  - Perceived by the projects to be non-value-added

Hefner, "Cutting Appraisal Costs in Half", 2007

Minimum Team Size

- **Cost is composed of:**
  - Team costs – goes up with team members
  - Organizational costs (interview, presentations) – largely fixed regardless of size



- **Accuracy goes up with as team size increases**

- **Buy-in is driven by the confidence the organization's members has in the appraisal process and appraisal team**
  - Larger teams can increase the likelihood that a respected person is on the team

Hefner, "Cutting Appraisal Costs in Half", 2007

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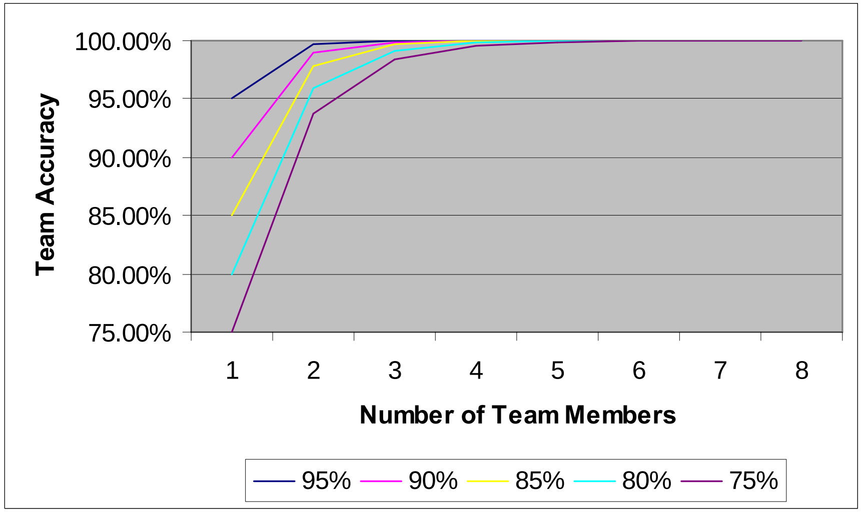
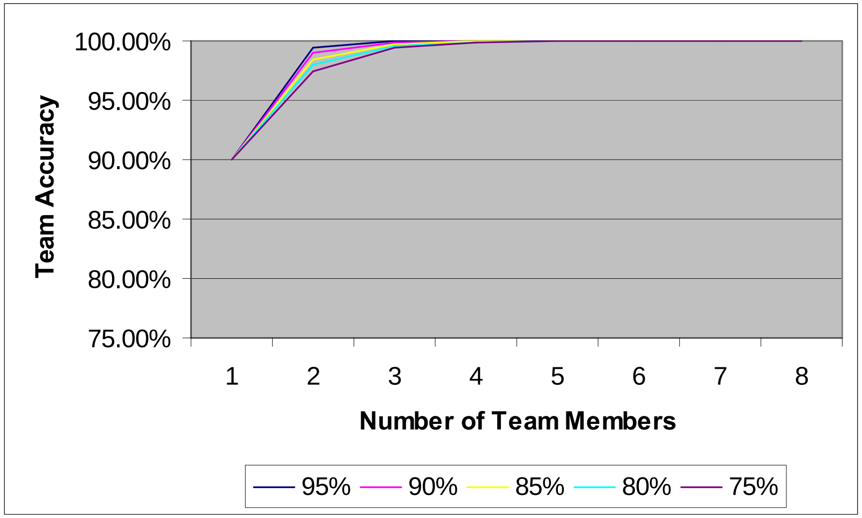
Team Accuracy vs. Team Size

- Team accuracy vs. team size, for given individual accuracies



- Same, assuming 90% leader accuracy



- As team size goes up, team accuracy rapidly increases (assuming the right answer is obvious once presented)
- Teams of greater than 4 provide little increase in accuracy

- If the team leader is 90% accurate, additional team members add little accuracy
- Adding team members does give a chance for them to learn

Appraiser accuracy, not team size, is critical

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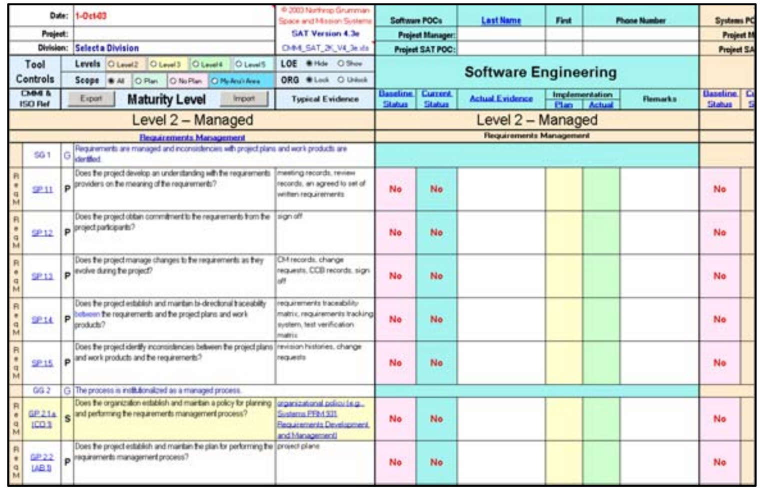
Evidence Mapping Should Use An Automated Tool



- **Key Tool Capabilities**
  - Point to existing project file structures
  - Capture status and needed actions
  - Provide statistics over time - project compliance, organizational compliance
  - Identify common gaps across projects
  - Identify typical evidence for each practice

- **Tips**
  - Finding the “right” evidence will involve iteration
  - Remember that the goal is <u>improvement</u> (learning/implementing new practices effectively), not finding/creating the evidence
  - Use workshops to educate, motivate, populate
  - Careful preparation reduces on-site evidence review time

Hefner, "Cutting Appraisal Costs in Half", 2007

NORTHROP GRUMMAN

Techniques for Reducing Cost   On-Site

- **Evidence review – Evaluating the gathered evidence to verify CMMI goal and practice compliance**
  - Remember the goal is to validate that the practice is performed, not to judge goodness of the document
  - Inexperienced appraisers should be coached to develop the proper perspective and speed
- **Interviews – Verifying the evidence is appropriate**
  - Not as important as evidence review
  - Simply verifies that what you saw is what is being used (verification, not discovery)
  - Not a test of practioners' memory
- **Consolidation – Using direct, indirect and affirmations to form judgments about goal and practices compliance**
  - Biggest time-waster

Hefner, "Cutting Appraisal Costs in Half", 2007

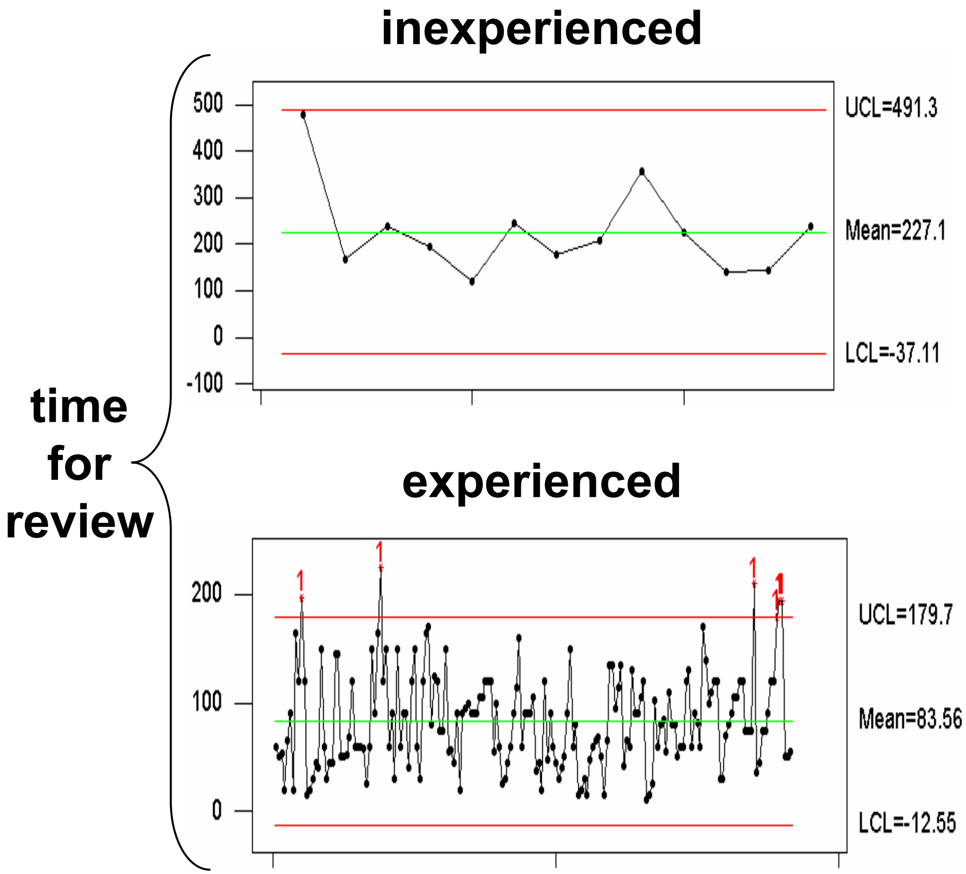
Reducing Interview Costs

- **To reduce cost:**
  - Use pre-scripted interview questions
  - Conduct interviews simultaneously in mini-teams (Remember that more than 3-4 people don’t increase accuracy much.)
  - Schedule one interview per practice & instantiation (no SCAMPI requirement for multiple interview sources like in CBA IPI)

Hefner, "Cutting Appraisal Costs in Half", 2007

NORTHROP GRUMMAN

Reducing Variation in Evidence Review



- **The time is takes to review evidence is predictable**
  - Some variation by process area
- **The mean review time and variation is much higher among inexperienced appraisers**
  - At least half of the appraisers on the team should be experienced
- **Review time is driven by the clarity with which evidence is assembled and mapped to the CMMI practices**
  - Ensure thorough evidence scrub prior to on-site period
  - Inappropriate evidence (“defects”) causes unexpected schedule overruns

Hefner, "Cutting Appraisal Costs in Half", 2007

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Reducing Consolidation Time

Crafting observations

- **Voice of Customer data indicates organizations and projects simply want to know which practices they do not comply with**
  - Consistent with Verification mode
  - No need to wordsmith charts
- **Use an Appraisal Findings tool to capture the ratings at the instantiation level (every project, every practice)**
  - Simplifies data consolidation, team discussion

Reviewing as a team

- **Most of the time is spent arguing about how to interpret a few CMMI practices**
  - Especially Generic Practices
- **We created "CMMI Interpretation" training which clarifies how ambiguous practices will be evaluated**
  - Driven by areas where disagreement occurred
  - Useful in reaching team (and organizational) consensus

Hefner, "Cutting Appraisal Costs in Half", 2007

Ten Most Misinterpreted CMMI Practices

- **Requirements Management**
  SP 1.4 Maintain Bidirectional Traceability of Requirements
- **Project Planning**
  SP 1.2 Establish Estimates of Work Product and Task Attributes
- **Project Monitoring and Control**
  SP 1.1 Monitor Project Planning Parameters
- **Measurement and Analysis**
  SP 1.1 Establish Measurement Objectives
- **Configuration Management**
  SP 3.2 Perform Configuration Audits
- **Verification**
  SP 2.2 Conduct Peer Reviews
  SP 2.3 Analyze Peer Review Data
- **Risk Management**
  SP 1.1 Determine Risk Sources and Categories
  SP 1.3 Establish a Risk Management Strategy
- **Generic Practices**

"The 10 Most Commonly Misunderstood CMMI Practices, " R. Hefner, CMMI Technology Conference and User Group, 17-20 November 2003
"Applying CMMI® Generic Practices with Good Judgment, " R. Hefner and G. Draper, CMMI Technology Conference and User Group, 15-18 November 2004

Hefner, "Cutting Appraisal Costs in Half", 2007

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Summary

- **Mission Systems is typically conducting Level 5 SCAMPI appraisals of 5-6 focus projects in 5-6 days**
  - Post-appraisal follow-up indicates >95% accuracy rate
- **We are continuing to look at ways to decrease cost and increase effectiveness and value**
  - Effective sampling using non-focus projects
  - Re-appraisals to prevent “back-sliding”
  - Handling evidence refresh
  - Combining with ISO 9000, AS-9100 appraisals

Hefner, "Cutting Appraisal Costs in Half", 2007

Process Compliance the Smart Way

Gary Natwick, Dean Wooley, Jack Lawrence
Harris Corporation / ISD

ommunications ion: What We Do...

HARRIS

Aviation electronics

Communications and information networks

Intelligence, surveillance, and reconnaissance

Space and ground satellite communications systems

Operations and support services

We innovate, integrate, and manage technology.

Getting There

HARRIS

- Background
  - Goals, sources, and references
  - Organizational-centric set of integrated processes
  - Maintaining process compliance
- Implementation
  - Product-centric approach
  - Reverse engineering to achieve simplification
  - Reuse of unique artifacts
  - Organization default artifacts and locations
- Validation
  - SCAMPI℠ Class C approach
  - SCAMPI℠ findings
- Summary

HARRIS

- Ensure expected artifacts are appropriate and adequate to provide objective evidence to measure process compliance
  - Organizational procedures using QA audits
  - CMMI® using SCAMPI℠ Class A/B/C appraisals
- Ensure each expected artifact description is clear and complete to explain why it is relevant
- Maximize the re-use of actual artifacts to minimize the number of unique artifacts
- Limit the impact to the programs by minimizing the changes

...ces & References

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- Integrated Process Manual (IPM)
- Process Compliance Monitor (PCM) tool
- Standard directory structure
- SCAMPI℠ v1.1Class A artifacts
  - November 2005
- CMMI®-DEV+IPPD v1.2 model
- CMMI®-DEV+IPPD v1.2 PIIDS

Integrated Processes

HARRIS

Å Organizational-centric set of integrated processes
  ï Integrated Process Manual (IPM)
  ï Compliance mapping to CMMI®
Å Collaboration across functional organizations
Å Repeatable processes with objective criteria
  ï Entry/exit criteria, inputs, outputs, verification, measures
Å Planning each process, and tracking against plan
  ï Tailoring standard processes and assets
Å Budgets, schedules, resources
Å Managing established baselines
Å Managing Stakeholder involvement
Å Measuring progress and improvement

ocess Manual

HARRIS

IPM

Program Management Processes

ÅProgram Planning
ÅEstimation
ÅProgram Monitoring and Control
ÅSupplier Acquisition & Management
ÅChange Management

Program Life-Cycle Processes

ÅRequirements Analysis
ÅSystem Architecting/Design
ÅDesign
ÅCode and Unit Test
ÅFabrication and Assembly
ÅProduct Integration
ÅVerification
ÅValidation
ÅProduction
ÅField Support

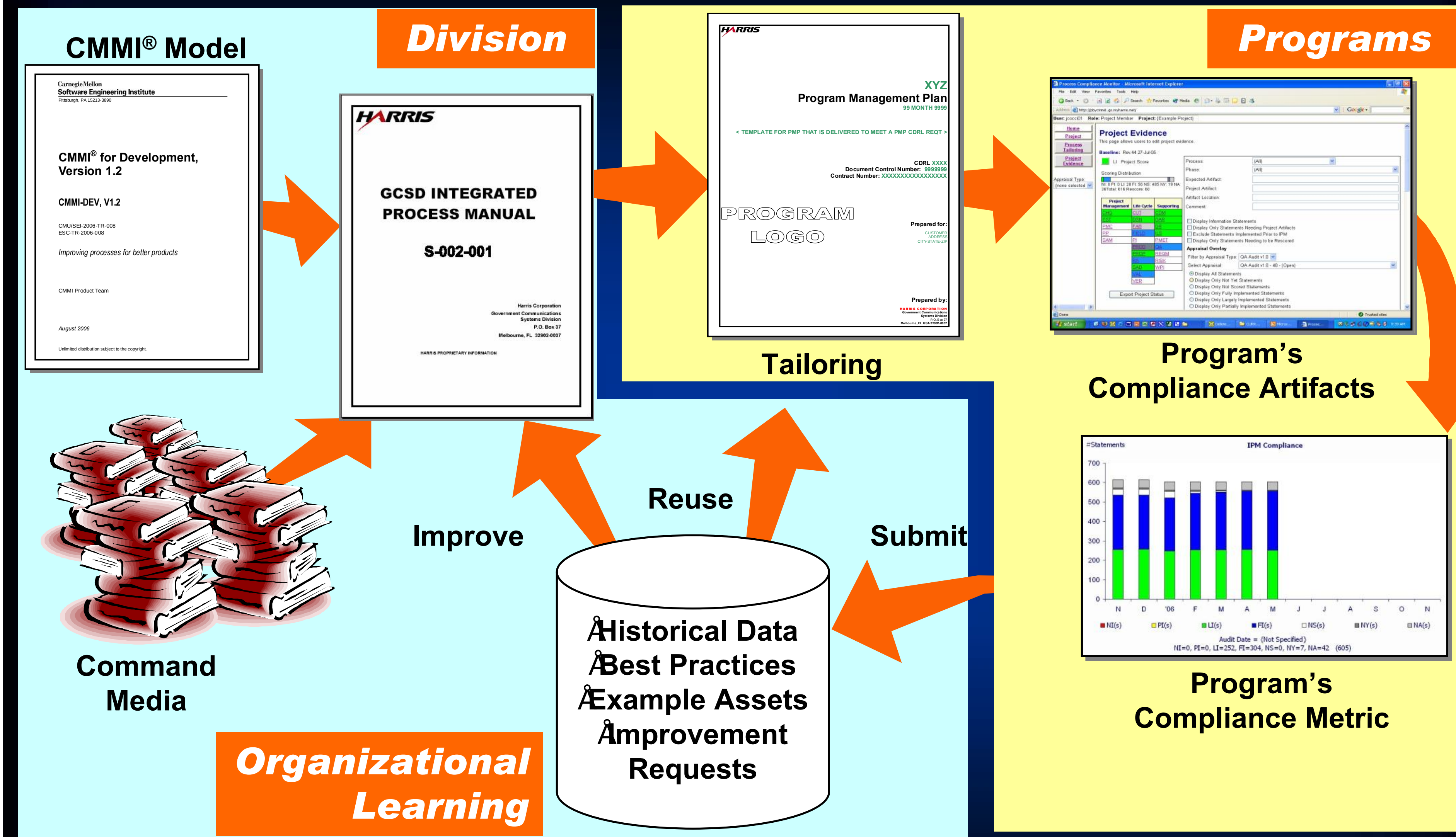
Program Support Processes

ÅRequirements Management
ÅRisk Management
ÅConfiguration and Data Management
ÅProgram Metrics
ÅDecision Analysis and Resolution
ÅWork Product Inspection
ÅDesign Review
ÅQuality Assurance
ÅIntegrated Logistics Support

Organizational Processes

ÅProcess Improvement
ÅTraining
ÅDivision Metrics

mpliance Approach



pliance

HARRIS

Integrated Process Manual

Tailoring

1. Program Plans
2. Program process baseline
3. Program execution
4. Compliance artifacts
5. QA verification
6. Non-compliance mitigation

Program Start-up

Program Phase Execution

Program Appraisals

Process Compliance Monitor (PCM)

o Industry Standards

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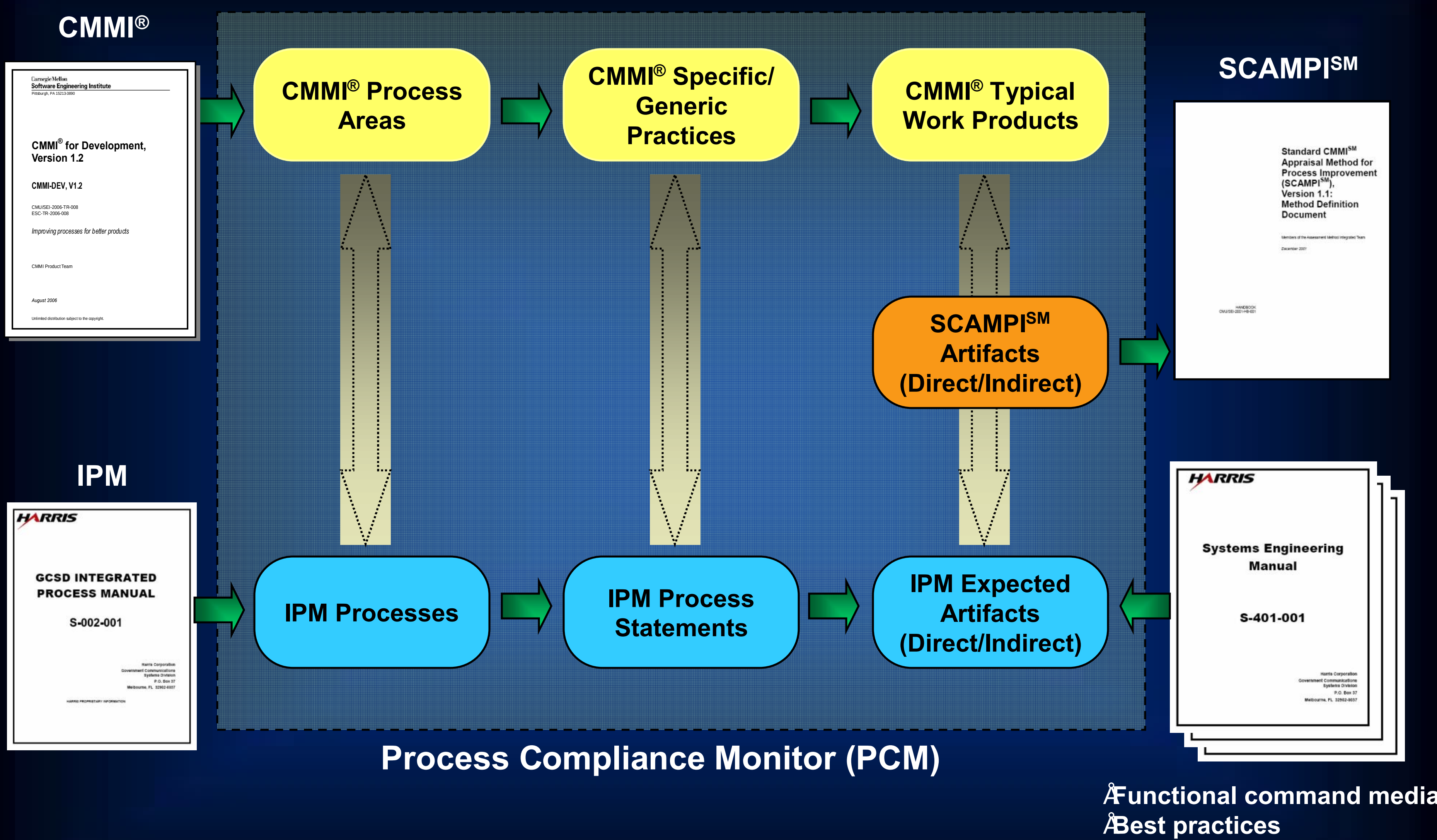

on

HARRIS

- Product-centric approach
- Reverse engineering to achieve simplification
- Reuse of unique artifacts
- Organization default artifacts and locations

ementation

HARRIS

- Programs are required to demonstrate compliance to the organizationôs integrated processes, as defined in IPM
- PCM tool is used to collect artifacts (i.e. work products)
  - Each process statement has one or more expected artifacts
  - Short description of each expected artifact provided
  - Program provides work product name and location that meets that expected artifact description
- PCM tool provides objective, online auditing and real-time monitoring of process compliance
  - QA conducts regular assessments of the artifacts to determine program compliance with IPM
  - Compliance scores are recorded in the tool
    - Available to the team and management in real-time
    - Reported monthly to division management

...ifacts required?

HARRIS

Overview
A brief description of the process intent

Entry Criteria
State, Prerequisites, Criteria

Exit Criteria
State, Criteria

Inputs
Needed work products, resources

Outputs
Resulting work products

Required Activities
Mandatory tasks to implement the process

Measures
Process performance against plans

Organizational Improvement Information
Metrics, reusable work products

Verification
Process compliance oversight

Tailoring
Approved tailoring, process specific

Implementation Guidance
Common implementation descriptions

Supporting Documentation and Assets
Applicable organizational references

(Yellow) Program artifacts needed to demonstrate IPM process compliance

...neer Artifacts[1]

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- Instead of looking from the process view – looked from a program work products view
- Basic guidelines
  - Every CMMI® practice shall have a minimum set of adequate expected artifacts in PCM
  - Every IPM statement shall have a minimum set of adequate expected artifacts in PCM
  - Every PCM artifact (existing or new) shall map to one or more IPM statements and CMMI® practices
  - Maximize the re-use of existing artifacts
    - PCM Startup Template
    - Standard Directory Structure

neer Artifacts[2]

- Mapped program work products to IPM statements and to relevant CMMI® practices
  - IPM mapping clearly documented in PCM tool
  - CMMI® mapping in PCM tool - transparent to the program
- Artifact descriptions clarified to help the program understand relevance
  - Descriptions let the program know why this artifact is important
  - IPM perspective
  - CMMI® perspective
- Provided name of typical project work product to be used as an artifact
- Provided standard directory structure location where that work product should be maintained

ectory Structure

- Supports IPM Compliance with artifacts in a common structure across programs
- Top level directories are used as location for program artifacts
  - Avoids tying PCM artifacts to low level directories
  - Easy access by all program team members
  - Avoids confusion as to which is the latest version of an artifact
  - Flexibility for custom directories which contain ñwork-in-progressò
- Pre-populated with latest forms, checklists and plan templates
  - Set up by IT group when program data server is assigned

...ctory Structure

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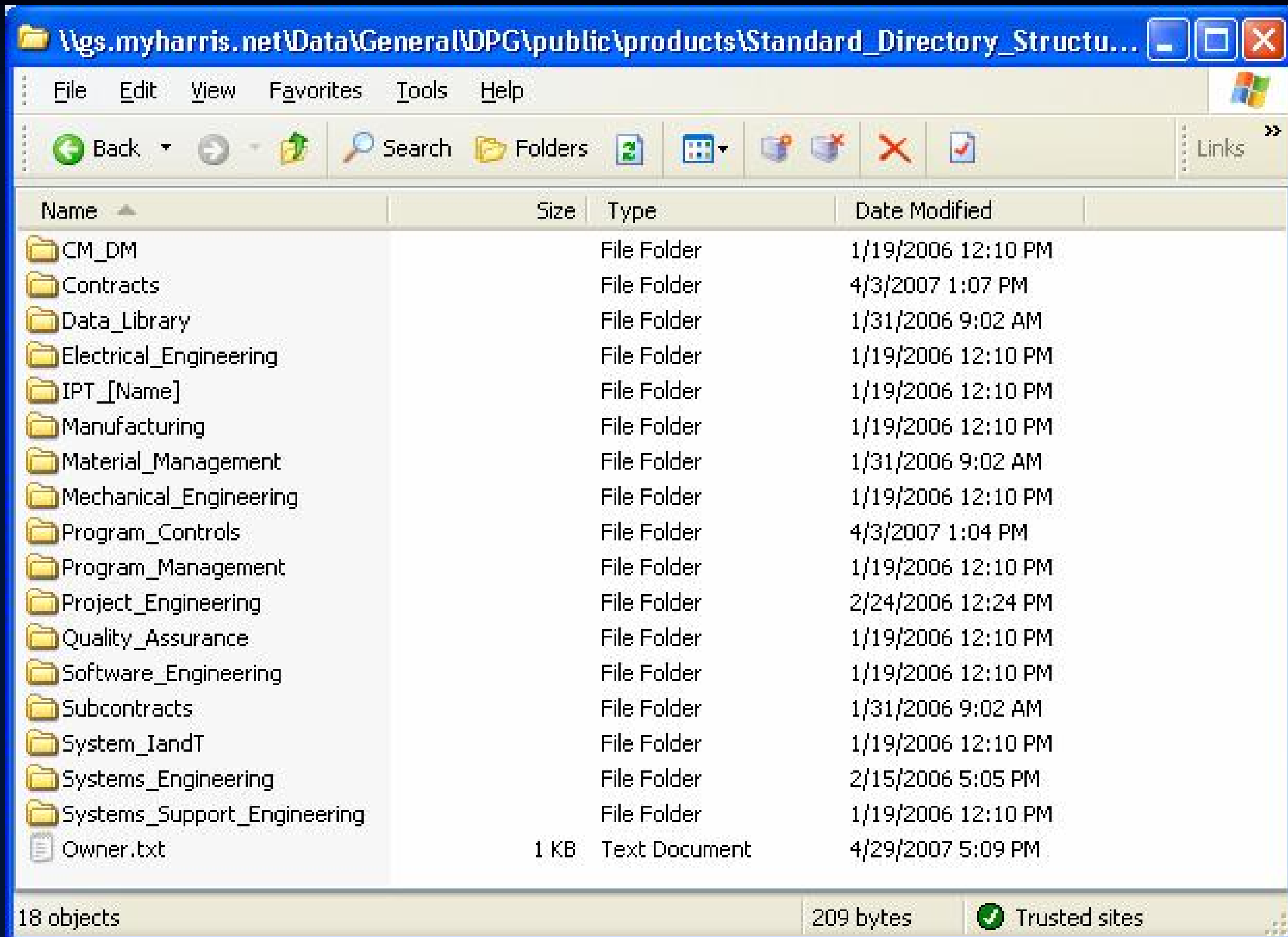

...ementation Results[1]

- Work products reused to support multiple process statements
  - Artifact descriptions provide the specific application
  - Minimized the number of unique work products that programs need to provide in PCM tool
- Tool repositories hold many of the program artifacts
  - DOORS, ClearQuest, Rose, Pro-E, etc.
- Some evidence/artifacts for a program may be subject to customer data requirements
  - Programs can tailor or change the expected artifacts to better align with their execution
  - Still required to comply with the IPM (and consequently CMMI®)

ementation Results^2

Å Significant reduction in the number of artifacts needed to demonstrate IPM compliance

ï Model-centric approach

Å 1360 unique artifacts

ï Product-centric approach

Å 326 unique artifacts

Å 718 pre-defined artifact descriptions

Å Complete mapping to CMMI® practices simplifies effort required for SCAMPI℠ preparation

ï Multiple artifacts map to CMMI® practices

- SCAMPI℠ Class C
  - Planning
  - Preparation
  - Data Review
- SCAMPI℠ Findings
  - Implementation Risk
  - Process Definition Characterizations

- Given three different sets of data develop a map to show the IPM to CMMI® relationships
  - IPM statements
  - CMMI® practices
  - IPM/CMMI® artifacts
- Capture a set of findings to characterize the process implementation risks and degree of process definition for each CMMI® practice
- Make the task of preparing for and conducting an appraisal as simple as possible

n

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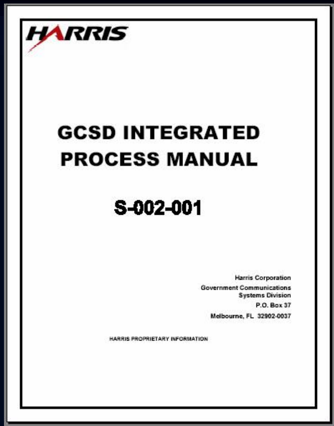
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GCSD INTEGRATED PROCESS MANUAL

S-002-001

Harris Corporation
Government Communications Systems Division
P.O. Box 37
Melbourne, FL 32902-0037

HARRIS PROPRIETARY INFORMATION

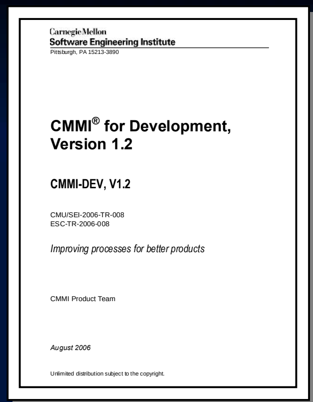
An interim appraisal of process activities to revalidate existing processes based command media against CMMI®ï DEV+IPPD v1.2

Context: Command media recently updated to reflect changes in the organizationõs process improvement goals. Desire to revalidate existing capability with respect to CMMI®ï DEV+IPPD v1.2

Appraisal Objective: Conduct a SCAMPI℠ C on the GSCD command media (documentation only) using CMMI®ï DEV+IPPD v1.2

Desired Outcome : Provide information that management can use to baseline process performance and to prioritize improvement actions

parations


Carnegie Mellon
Software Engineering Institute
Pittsburgh, PA 15213-3890

CMMI® for Development, Version 1.2

CMMI-DEV, V1.2

CMU/SEI-2006-TR-008
ESC-TR-2006-008

Improving processes for better products

CMMI Product Team

August 2006

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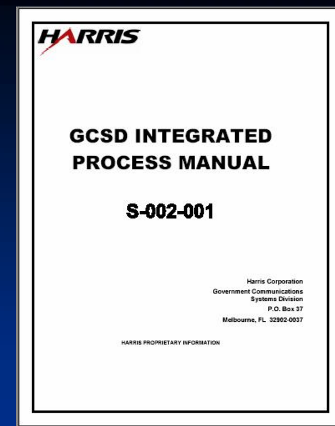
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GCSD INTEGRATED PROCESS MANUAL

S-002-001

Harris Corporation
Government Communications Systems Division
P.O. Box 37
Melbourne, FL 32902-0037

HARRIS PROPRIETARY INFORMATION

- ÅEstablish IPM to CMMI® relationships
- ÅLoad IPM into appraisal tool (Appraisal Wizard)
- ÅEstablish a list minimum but complete set of artifacts each IPM statement
- ÅAutomatically map artifacts to CMMI® which is our starting point for the appraisal

Mapping

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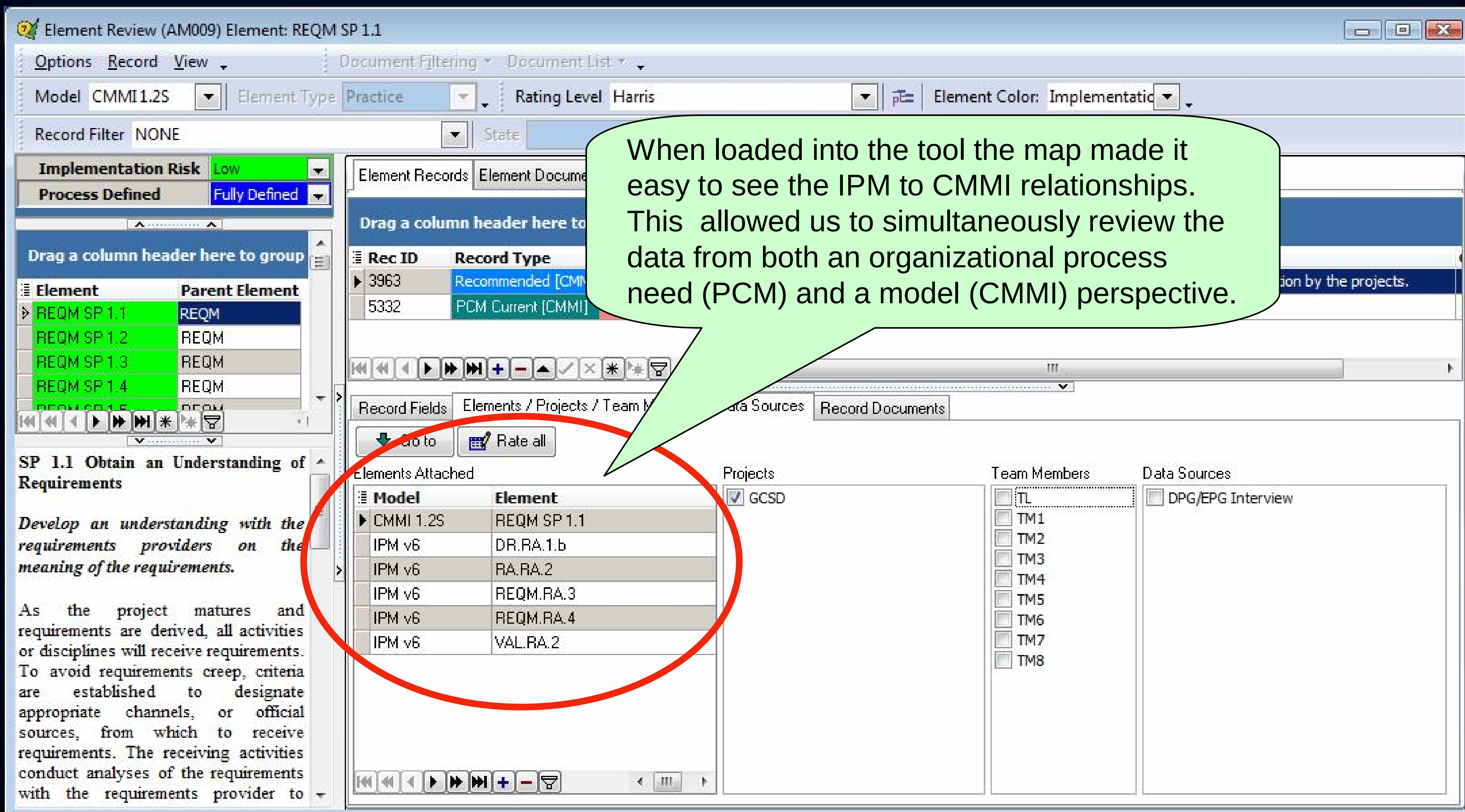


When loaded into the tool the map made it easy to see the IPM to CMMI relationships. This allowed us to simultaneously review the data from both an organizational process need (PCM) and a model (CMMI) perspective.

ngs

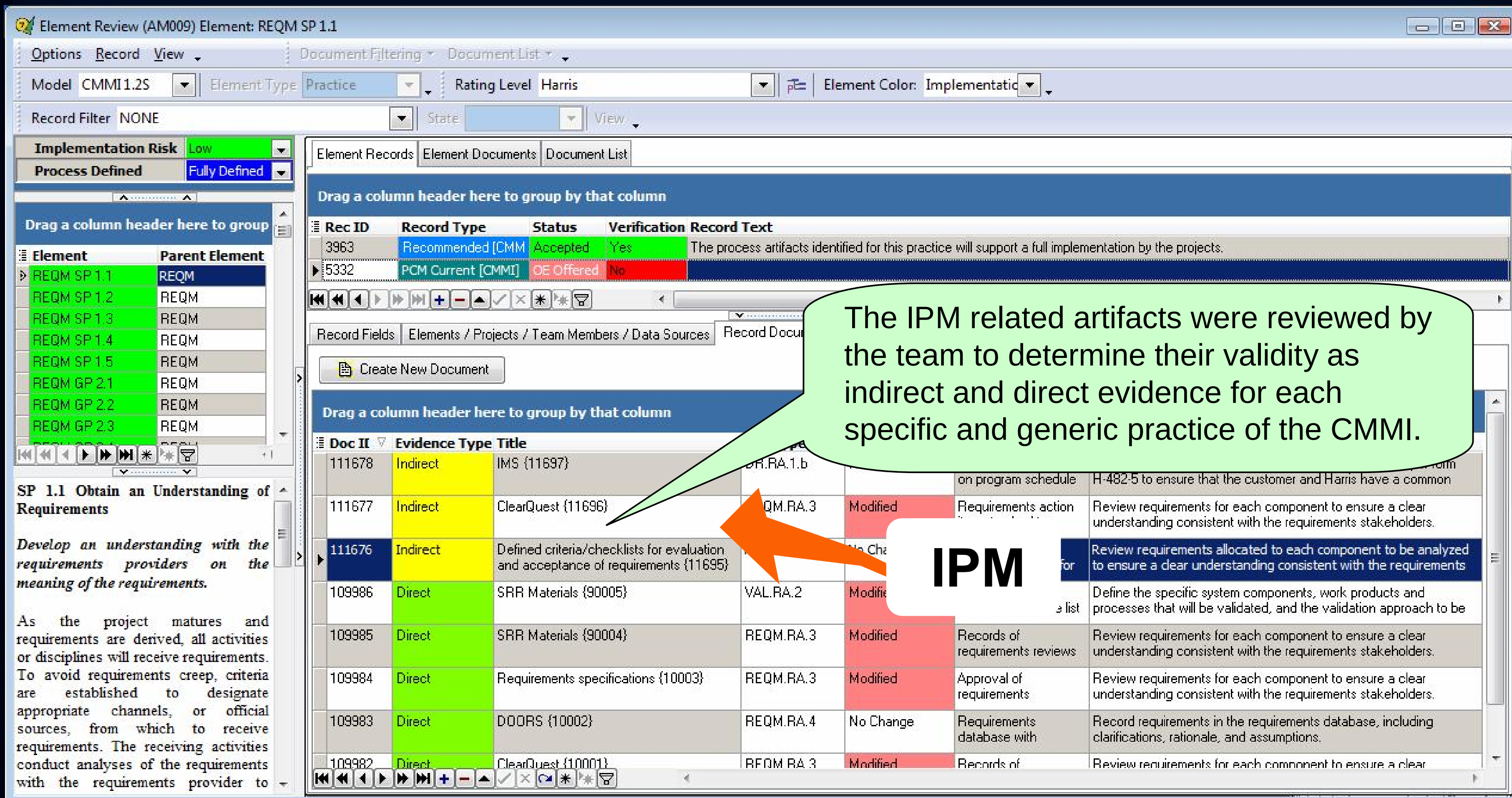
Å Compared the required data (as defined in the IPM) to that needed to satisfy the model

Å Adjusted the total dataset as needed to correctly reflect artifacts as direct and indirect evidence or to remap them if mapping errors were found

Å Team consensus on the necessity of each artifact to demonstrate complete implementation of a practice

Å Concise set of summary findings statements to reflect the adequacy of the data set and potential risk of successful deployment and implementation

rtifacts


The IPM related artifacts were reviewed by the team to determine their validity as indirect and direct evidence for each specific and generic practice of the CMMI.
IPM

for Each Practice

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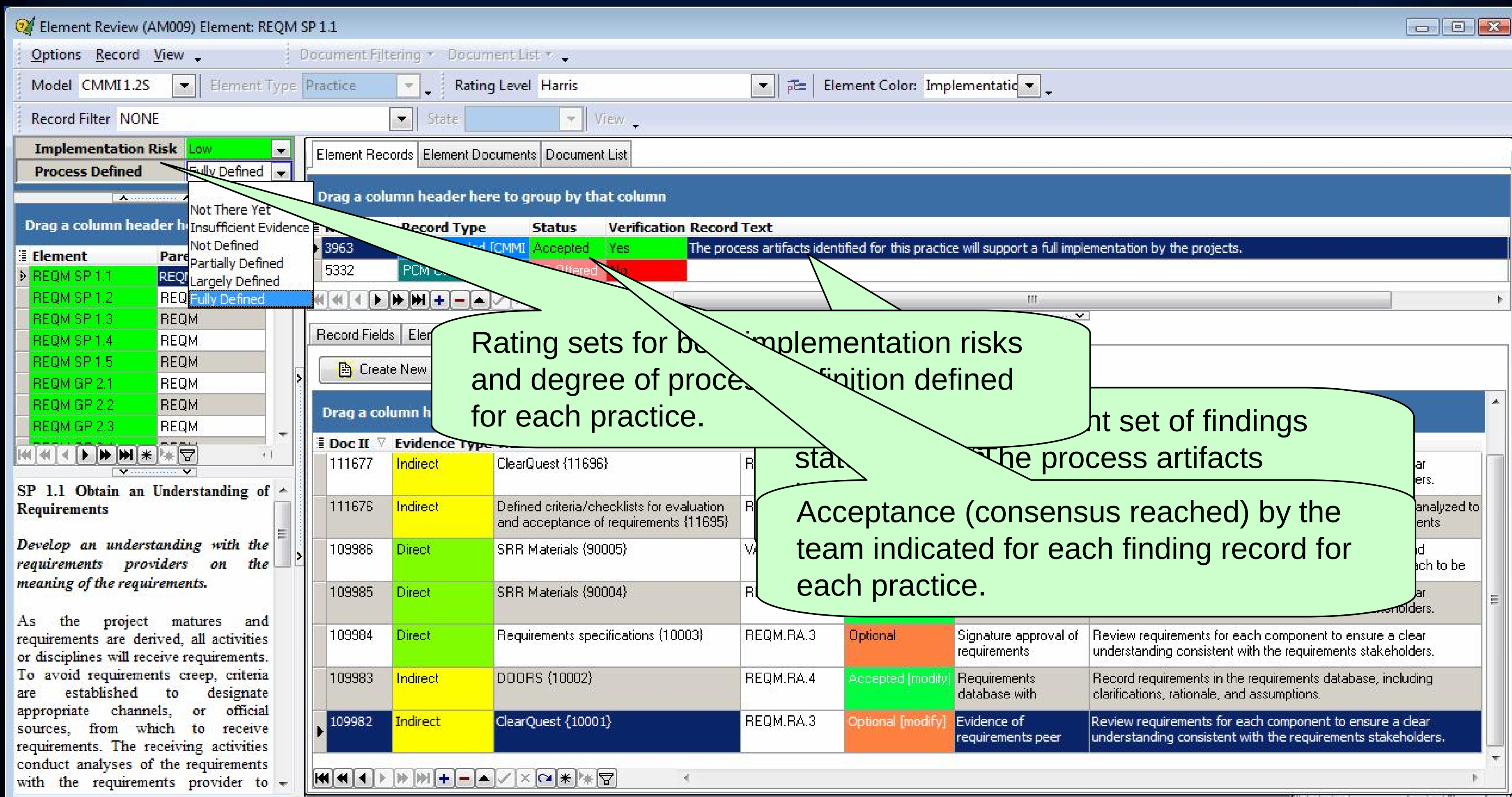

tion Characterizations

HARRIS

Fully Defined (FD)	One or more direct artifacts are present and judged to be adequate At least one indirect artifact exists No weaknesses are noted
Largely Defined (LD)	One or more direct artifacts are present and judged to be adequate At least one indirect artifact exists One or more weaknesses are noted
Partially Defined (PD)	Direct artifacts are absent or are judged to be inadequate One or more indirect artifacts suggest that some aspects of the practice are defined One or more weaknesses are noted - OR - One or more direct artifacts are present and judged to be adequate No other evidence (indirect artifacts) supports the direct artifact(s) One or more weaknesses are noted
Not Defined (ND)	Direct artifacts are absent or judged to be inadequate No indirect artifacts support the practice implementation One or more weaknesses are noted

s/Artifacts

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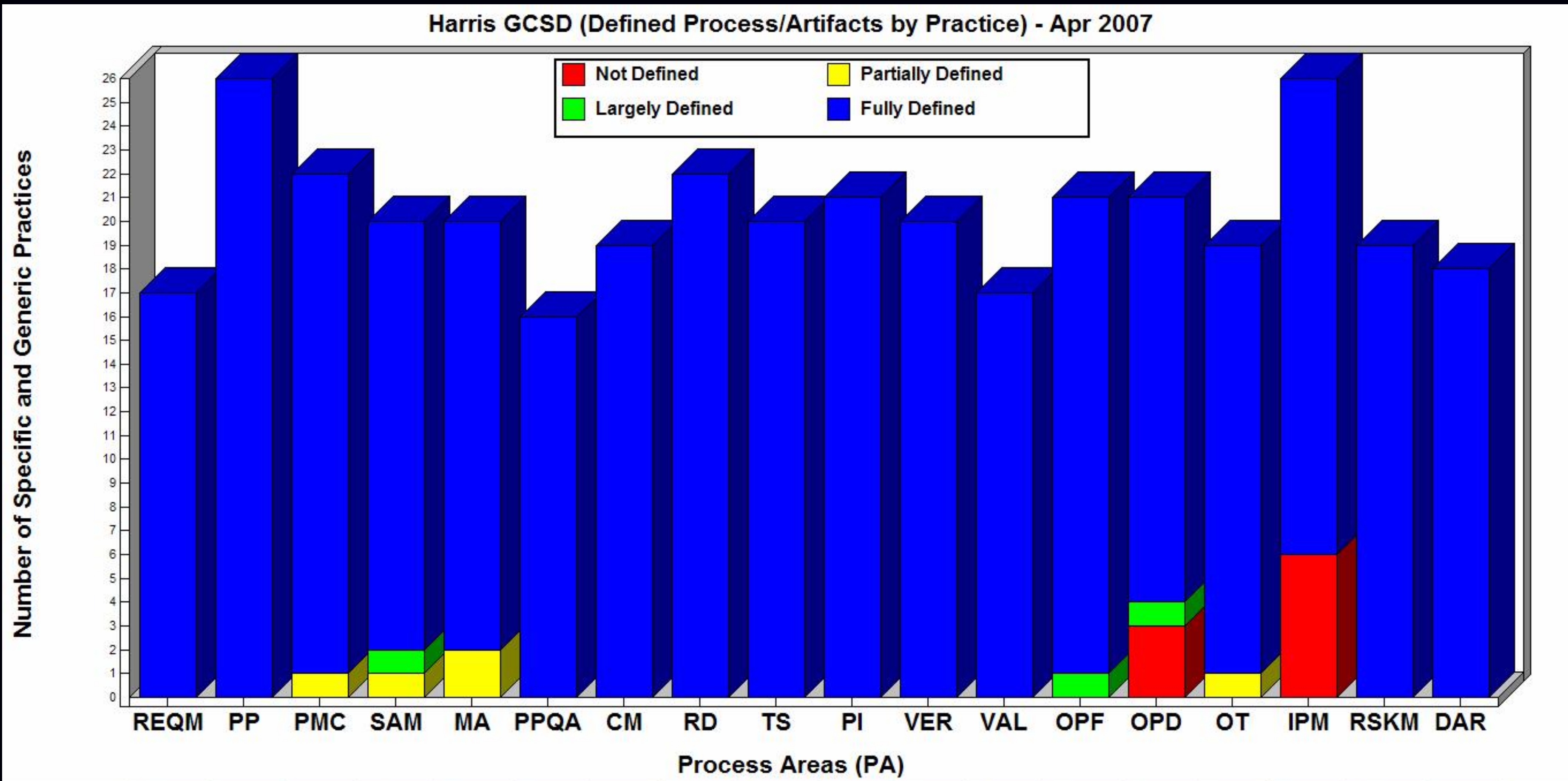

	REQM	PP	PMC	SAM	MA	PPQA	CM	RD	TS	PI	VER	VAL	OPF	OPD	OT	IPM	RSKM	DAR
Not Defined	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	6	0	0
Partially Defined	0	0	1	1	2	0	0	0	0	0	0	0	0	0	1	0	0	0
Largely Defined	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Fully Defined	17	26	21	18	18	16	19	22	20	21	20	17	20	17	18	20	19	18

Note: Weaknesses subsequently mitigated to achieve Fully Defined

plementation Risk

Label	Meaning
Red	The intent of the model practice is judged to be absent or poorly addressed in the set of artifacts identified – gaps or issues that will prevent goal achievement, if the deployment occurred in this way across the organizational unit, were identified.
Yellow	The intent of the model practice is judged to be partially addressed in the set of artifacts – some gaps or issues were identified, which might threaten goal achievement if the deployment occurred in this way across the organizational unit.
Green	The intent of the model practice is judged to be adequately addressed in the set of artifacts identified – in a manner that would support goal achievement, if the practice were deployed across the organizational unit.

entation Risk

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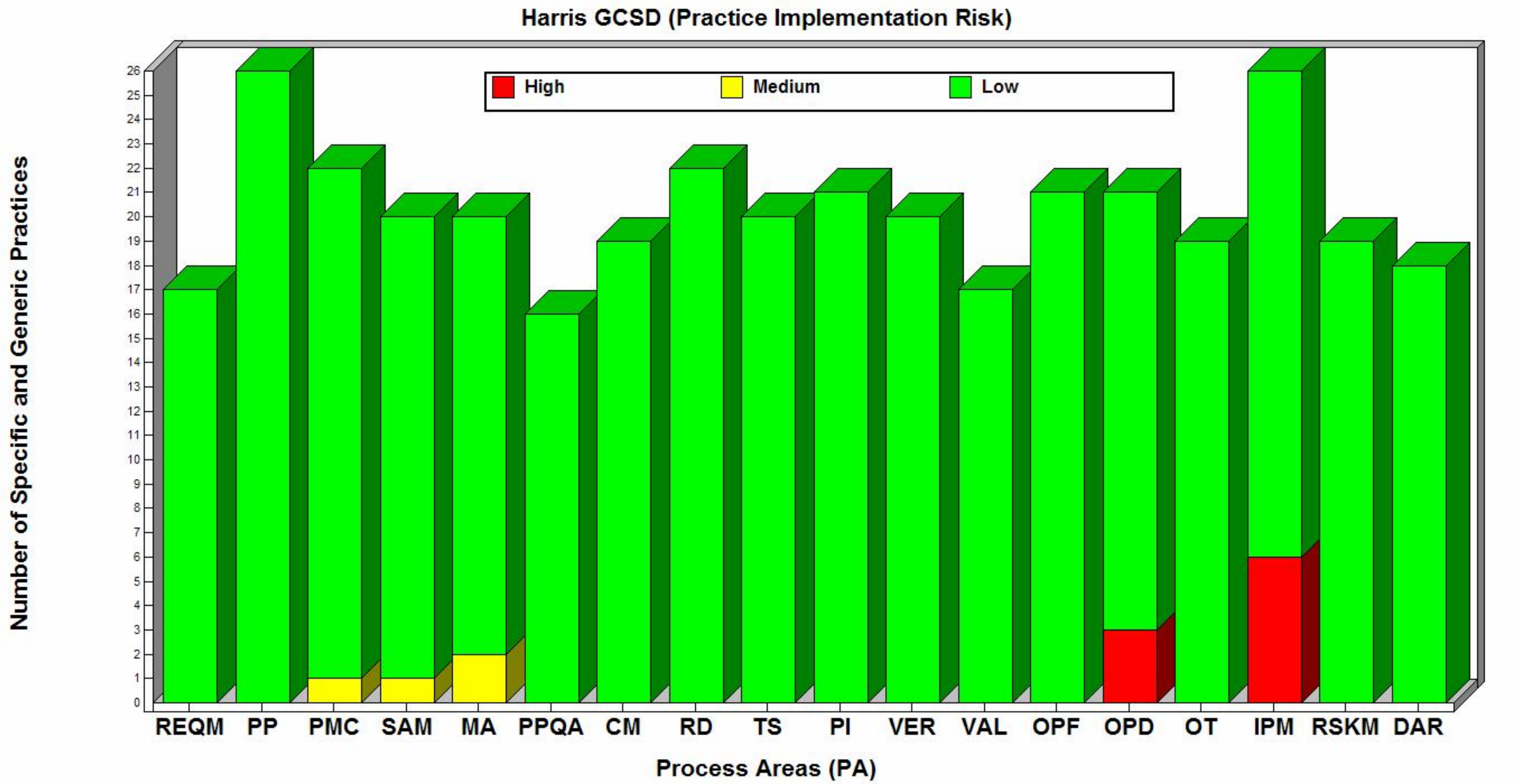

	REQM	PP	PMC	SAM	MA	PPQA	CM	RD	TS	PI	VER	VAL	OPF	OPD	OT	IPM	RSKM	DAR
High	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	6	0	0
Medium	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Low	17	26	21	19	18	16	19	22	20	21	20	17	21	18	19	20	19	18

Note: Weaknesses subsequently mitigated to achieve Fully Defined

HARRIS

- Å Product-centric approach
  - ï Practical and proven to applying across organizational and CMMI® process areas and practices
  - ï Efficient project data collection
  - ï Fewer redundant findings
  - ï Improved support for projects and the organization
  - ï Maintains integrity of the appraisal method and achievement of sponsor objectives

mation

HARRIS

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SEI Partner

Gary Natwick gnatwick@harris.com

- SEI-Authorized Introduction to CMMI® Instructor
- SEI-Authorized SCAMPI℠ Class A Lead Appraiser (former)
- SEI-Authorized SCAMPI℠ Class B&C Team Leader (former)
- Harris SEI Partner Business & Technical Point of Contact

Dean Wooley dwooley@harris.com

- Member of American Society for Quality (ASQ)
- ISO-9001 internal auditor
- Appraisal Team Member in SCAMPI℠ Class A&C

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Jack Lawrence jlawrence@isd-inc.com

- SEI-authorized Introduction to CMMI® Instructor
- SEI-authorized SCAMPI℠ Class A High Maturity Lead Appraiser
- SEI-authorized SCAMPI℠ Class B&C Team Leader
- eSCM Lead Evaluator
- eSCM-SP Instructor

Integrated System Diagnostics INCORPORATED

Lessons Learned Conducting a High Maturity SCAMPIs

Paul D. Byrnes
Principal and CTO

Presented at
CMMI Conference
November 15, 2007

◈ *This presentation includes some tailored and updated material previously presented by Mr. Byrnes at the 2007 SEPG conference*

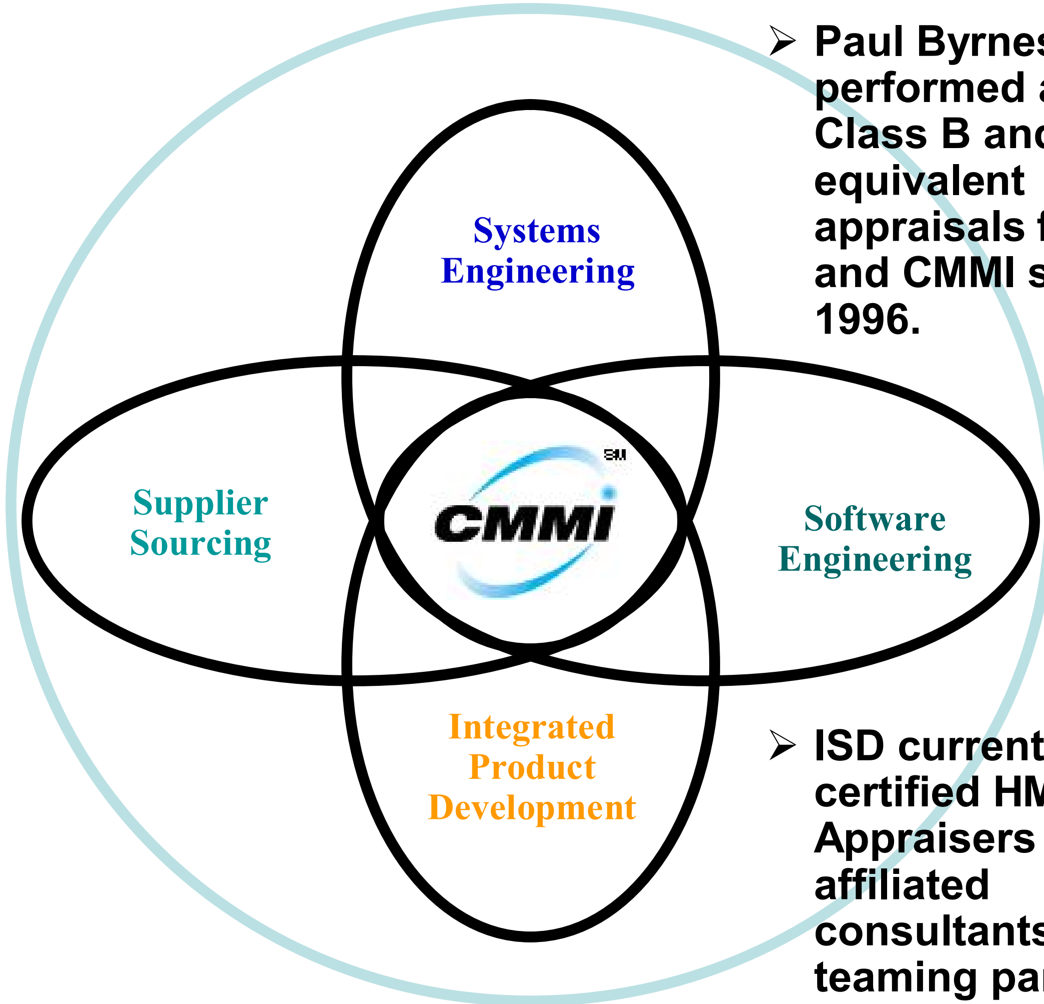
Scope of Events Discussed

- 5 Level 4-5 SCAMPI A appraisals over last 3 years

- SE/SW (integrated)
- SE/SW (separate ratings)
- SE/SW/SS
- SE/SW/IPPD/SS

- All achieved their desired target. One exceeded their target. One was a re-appraisal.

- Roughly one third of the organizations providing data to the SEI for their latest “benefits” report are ISD clients.



- Paul Byrnes has performed app. 30 Class B and Class A equivalent appraisals for CMM and CMMI since 1996.

- ISD currently has 10 certified HM Lead Appraisers as staff, affiliated consultants, and teaming partners out of 123 total as of 11/12/07.

Less Process Areas Doesnât Mean Less Effort!

4 more Process Areas at Levels 4-5 doesn't mean only 22% more effort!!

Heed the SEI published data on time to move up maturity levels!

Going from Level 3 to 4 in less than a year would require special cause analysis.

Level	Focus	Process Areas
5 Optimizing	*Continuous Process Improvement*	Organizational Innovation and Deployment Causal Analysis and Resolution
4 Quantitatively Managed	*Quantitative Management*	Organizational Process Performance Quantitative Project Management
3 Defined	*Process Standardization*	Requirements Development Technical Solution Product Integration Verification Validation Organizational Process Focus Organizational Process Definition Organizational Training Integrated Project Management Risk Management Decision Analysis and Resolution
2 Managed	*Basic Project Management*	Requirements Management Project Planning Project Monitoring and Control Supplier Agreement Management Measurement and Analysis Process and Product Quality Assurance Configuration Management
1 Initial		

Quality
Productivity

Risk
Rework

Common Goals ï High Maturity Impacts

Common Goal	Sub-Goal	High Maturity Appraisals
Ensure results	Contribute directly to business improvement Comparable across companies/organizations	Increased specificity required Integrating with other assessments desired
Optimize value to sponsors	Support business objectives Optimize cost and minimize disruption	Multiple requirements must be satisfied Enterprise focus
Ensure appraisal reliability	Create repeatable processes ï standardize Make results predictable and differences explainable Results independent of team composition	Desire for objectivity increases Use of external resources increases

Slide adapted and updated from presentations by Mr. Byrnes while managing the appraisal project at the SEI.

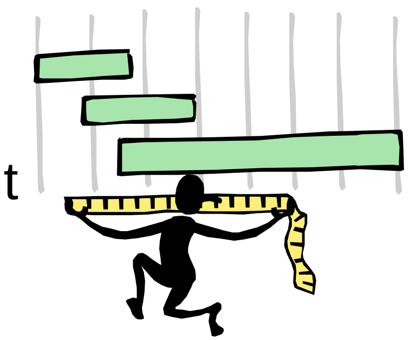
ddressing Common Risks

Risk	Factors	High Maturity Counter Points
Insufficient senior mgt. commitment	Caused by turnover or mergers Based on disillusionment with results Resulting from shifting investment priorities	Management changes generally donôt ñstopòthe process or the improvement activities.
Middle mgt. resistance	Overriding pressure for project performance; Incentives on delivery, not quality Doubt about seriousness of senior leadership	Always a factor. Customer drivers impact perspective.
Inappropriate goals	Level 5 in 1 year 75 business units to be assessed by year end	Goals not based on level attainment
Unrealistic expectations	The great productivity gap related to managing change The technology adoption curve and change management awareness Lack of continuous focus on process improvement	Data driven. Knowledge of what can be achieved. Customer focused.
Crash implementations	No plans or long-term perspective, and lack of following through on improvement efforts Termination of activities before they are institutionalized	Lots of efforts at any one time. Not one ñmegaòeffort. Several methods in tool kit.

Slide from Paul Byrnesô2nd ISD Customer Conference presentation

Message: Appraisals as Risk Management

- Spend extra time up front defining the organization scope.
- Take an integrated approach to process deployment.
- Target a model scope that makes sense for your current state, business goals, and business environment.
- Conduct informal, but robust, interim appraisals (Class C, Class B) as a risk reduction technique.
- *Frankly, these apply to all appraisals, high maturity units are just better at it….*



These lessons are paraphrased from one of ISDôs CMMI customers, as reported in 2003 in a public forum

Some Example High Maturity Teams

This was the ñoldestò appraisal

Team Size	Days on site for A	Team Comp.: External – External to OU – Internal to OU	Effort hours /Team Member
10	15	4 ï 0 ï 6	134
9	10	1 ï 2 ï 6	93
8	10	2 ï (1 and 1) ï 4	96
8	10	1 ï (2 and 2) ï 3	95
8	10	2 ï 4 ï 2	86

This was the ñlatestò appraisal

Notice the trend!

Is there are trend??

Lessons Implemented ï Tailoring

Some key SCAMPI HM tailoring and variations from the standard process commonly used in the past and for low maturity events

- organization preparation starts *much* sooner
  - more time allocated to the entire event (if attempting full coverage and ratings and multi-discipline events)
  - *more preparation time* allocated to designing appropriate interview sessions (size, scope, type, etc.)
- team selection and composition even more critical ï *high maturity experience, SPC skills, inside/outside unit, specialized training*
- longer, integrated organization in-brief needed ï *discussion of goals, models/baselines, subprocesses required*
- need for automated tools increased ï expansion in data elements required increases *need for different approaches to recording data*

Slide adapted from pdb SEPG 2001 presentation

Project Selection Challenges

- Organization Coverage: large units have a real challenge of showing institutionalization across the entity when only reviewing a small set of projects in a Class A ï *how many instances is enough?*

- Model Coverage: projects with institutionalized practices which reflect model requirements: *In high maturity events, the need to bring in additional data from "non-focus" projects increases.*

- Life Cycle Coverage : This effects all appraisals, but is exacerbated in level 4-5 events *due to natural life cycle implementation durations for these kind of measurement intensive processes.*

- Functional Coverage: no different issues than in a typical appraisal ï *but there may be more groups that need to be covered.*

Objective Evidence Challenges

- High maturity processes *demand more instantiations* than just a ñone direct, one indirectòapproach.

- Example: in OID, seeing one example of a systems engineering tool being deployed is woefully incomplete for judging organization institutionalization
  - What about software?
  - What about a major process change?
  - What about supplier management?
  - What about large programs that maintain their own baselines?
  - What about IR&D and CR&D projects?

Lessons Implemented - Evidence

- Organize objective evidence in a user-friendly manner
  - *Must* provide guidance for interpreting objective evidence
  - Store evidence electronically ï Use automated tooling.
  - Review the evidence for consistency *before* the event

- Develop ñthreadsòto follow high maturity concepts in a more natural and flowing manner ï *present evidence by “topic” rather than CMMI practice buckets*

- Use interim (C and B) appraisals to incrementally ñbuildò the appraisal database ï *HM events are typically not just a big bang single event*

Lessons Implemented - Conduct

- Ensure most (all??) team members get insight into the high maturity practices being implemented
  - Facilitates the final consolidation process
  - Leverage ñoverlapsòand ñdependenciesòin the model (and threads) to assign mini-teams
  - Mini-teams usually have ñinside-outsideòmembership to maximize objectivity while benefiting from ñinsideròknowledge
- High Maturity events require different, additional interview participants
  - Example: for OID, Internal Research and Development (IR&D) projects
- Use parallel interview sessions for some self-contained (e.g., SAM) ï maximize time for whole team on HM sessions and tasks.
  - Perform parallel splits for topics that are generally or easy to parse between org an projects (e.g., OPF)

HM Appraisal Considerations

Appraisal practices (examples)	Implementation issues/risks/recommendations	Appraisal considerations
Plan the Process (GP 2.2)	Organizations often donõt know how much data is needed relative to prior events when increasing model and discipline scope.	Must engage outside Lead sooner in internal planning stages. Sampling strategies
Identify and Involve Stakeholders (GP 2.7)	Very broad set of stakeholders. Easy to miss key people. May involve groups not previously part of low maturity appraisals.	When ñnewò groups involved, they exhibit ñlow appraisal maturityò despite organization overall process capability.
Establish a Defined Process (GP 3.1)	Organizations often focus on procedures *within* processes, rather than with interfaces, coordination, synergy, and integration across.	Look for threads. Sets of documents that describe connections across process elements.
Review Status with Higher Level Management (GP 2.10)	Many issues and decisions can be driven down to lower levels ï delegate responsibility.	Manage the effort like a project. Decompose the problem. Track metrics. Set norms up front. Do training even if they already had it.
Manage Configurations (GP 2.6)	Data across company likely to be in multiple repositories. Significant IT, security	Need for good CM to manage incremental appraisal database build up and reuse over several events.

Common Pitfalls in HM Appraisals

- ñProcess improvement team centric PIIDsé .ò
- ñSince this is a L5 appraisal, it has to take 4 weeksé ò
- ñSince I am the same Lead Appraiser that appraised you last time, this HM event will be easyé .ò
- ñWe have been doing this forever, letôs just hire the Lead Appraiser two months before the A.ò
- We hired a great SPC consultant to help us, letôs not worry about interacting with our Lead regarding our interpretationsé .ò
- We were HM last time, why do we need to be concerned with SEI nowé ?ò

Appraisal Project Management

- Planning phase is longer than a ñtypicalò L2-3 appraisal
- Ensure LA counters pre-disposition to spend less effort in diligence on lower maturity PAs
- Align all applicable goals and objectives
  - Organizationôs business objectives, PI objectives, Quality and Process Performance Objectives AND the appraisal objectives
- Use of appraisal historical data for planning
- More sophisticated sampling approaches
- LA ñmodelsò high maturity behavior

Increased Skills Needed

- Integration, Articulation and Expression of Information
  - Increased need for specialized communication skills
  - Ability to describe behavior with examples/scenarios/stories ï thread based appraisal rather than ñpractice basedò appraisal
  - Ability to express infrastructure necessary to successfully implement L4-5 [e.g., IPM tailoring to L4 QPM metrics ñtailoringó]
- Understanding and Adapting to Organizational Context
  - Understanding Business Goals and Concerns, Understanding Organization structure, context, environment, and culture, and activities deployed to resolve problems
- Examining High Maturity Organizational *Behavior*
  - Knowing what to look for and what to ask about (Both org and project)
  - Understanding model interpretations (not just *literal* words of model, but *intent*)

Increased Skills Needed ï 2

- Understanding an array of quantitative and statistical management metrics/techniques that may be applicable depending on the context
  - Ability to differentiate statistical from quantitative methods
  - Ability to accept appropriate quantitative methods as reasonable L4-5 behavior
  - What is the answer to ñhow much is enoughò HM application in different settings
- Greater emphasis on need to understand change management and technology transition methods
- Ability to ñintegrateò rather than de-compose [holistic perspective}
- Ability to explain, and reach agreement on, HM concepts with sponsors, participants, and team members
- HM appraisals tend to shift burden on LA in what/how to communicate to stakeholders (due to increased skills of sponsor/team members)

Model Interpretation Issues ï 1

- What is enough application of a quantitative technique?
- Characterization and rating ï CL vs. ML
- Interrelationships and iterative nature with CL-ML4/5
- L4&5 as evolution of L2&L3; not distinct/separate
- *Subpractices and informative materials have "heavier weight" at ML4/5? [See also several recent SEI briefings corroborating this]*

Model Interpretation Issues ï 2

- How much is enough implementation evidence, how much appropriate SPC/quantitative analysis, etc.
- ñJust making itò versus continuing to evolve, etc.
- Recognize when appropriate tools, techniques, etc are being applied (viable vs. ñgoodò)
- Life after Level 5 ï show things continuing/evolving on reappraisal; how much improvement do we need to see?

Common Pitfalls Implementing HM Practices

- ñOk, it took us 12 months to do L3, weôll be able to L4 is 6 monthsé .ò
- ñWe have one good example of SPC in engineering, why would you want to see more é .ò
- ñWe do one control chart great, we just forgot about all our other metricsé ò
- ñWe do six sigma, therefore we are L5é .ò
- ñCorporate has two process performance models ï they donôt relate to what we do in this unit, but OPP is oké .ò
- ñWe do causal analysis, we must be L5 é .ò
- ñWe have lots of pretty charts, what else would we needé ò

Some Key High Maturity Take Aways

- Management is heavily embedded in the process.
- High maturity organizations can manage/sustain performance in spite of routine organizational ñshocks.ò
- Direct customer/user involvement in the improvement process is high.
- No single ñmethodòor ñmodelòused ï a tool kit is used.
- Most are not doing the practices because they want Level 4-5.

Different Behaviors in HM Orgs (Really!)

- The organization keeps an eye on the outside world for innovations.
- High ñpeople to peopleò guidance provided. Much more ñcoaching.ò
- Current and desired capability of processes is understood. Variations across tailoring parameters is known and factored.
- Work is aligned with business objectives and customer needs.
- Many ñadditionalò roles are actively involved.
- ñIntegrated teamsò review and analyze data, and make improvements.

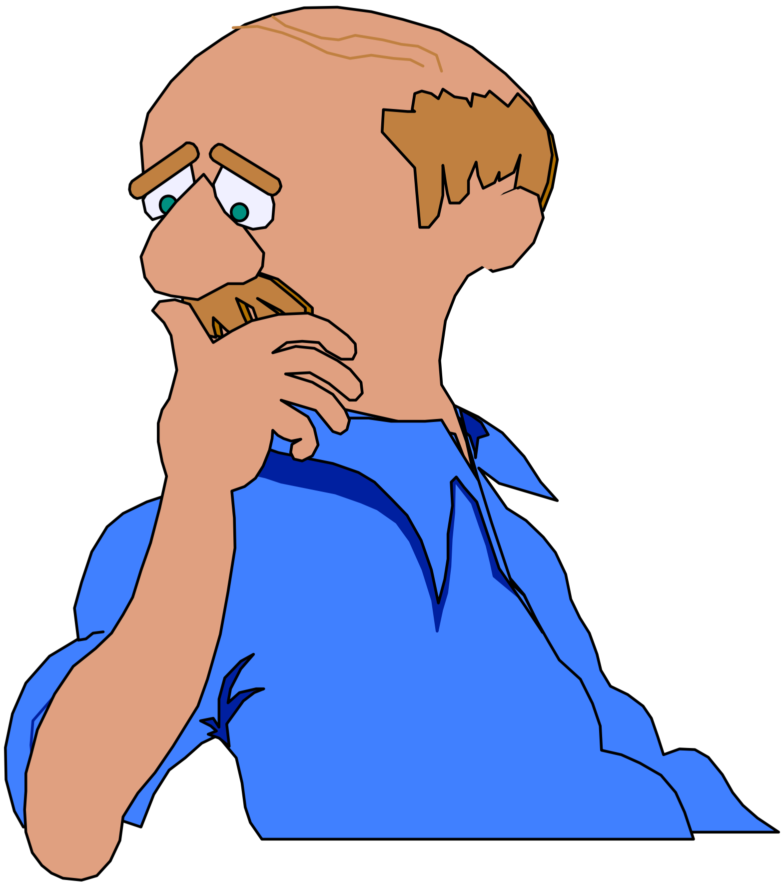
Key HM Organizational/Appraisal Challenges

- Organizational
  - Too many models. Too many methods. Multi-model appraisals.
  - Management drivers for reduced costs.
  - Increasing efficiency of both internal improvement and external appraisal efforts.
  - Customer ñdisconnectsò between ñlevel achievementò and ñproject performance.ò

- Appraisal
  - May be hard for organizational participants to ñdescribeò things to external team members.
  - Thread based appraisal vs. practice based appraisal
  - Data element needs increase substantially.
  - Some SCAMPI rules can actually get in the way

Questions and Answers

- Q
- &
- A



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DEFINING THE FUTURE

Lower Cost, More Effective Alternatives to SCAMPIs

CMMI Technology Conference & User Group
12-15 November 2007

Rick Hefner
Northrop Grumman Corporation
Director, Process Management
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Background

- As a set, the SCAMPI methods provide a powerful set of tools to use in CMMI adoption
- However, there are some situations in which these three methods are not appropriate, or are not cost-effective
- This presentation will discuss the features and limitations of the three methods, and alternatives that should be considered

Characteristics of CMMI Appraisal Classes

The ARC (Appraisal Requirements for CMMI) defines appraisal classes

- A guide to inventors of appraisal methods, and their customers

Key differentiating attributes for appraisal classes include

- the degree of confidence in the appraisal outcomes
- the generation of ratings
- appraisal cost and duration

***Appraisal Requirements for CMMI, Version 1.1**, CMU/SEI-2001-TR-034*

Characteristics	Class A	Class B	Class C
Amount of Objective Evidence Gathered (relative)	High	Medium	Low
Ratings Generated	Yes	No	No
Resource Needs (relative)	High	Medium	Low
Team Size (relative)	Large	Medium	Small
Appraisal Team Leader Requirements	Lead appraiser	Lead appraiser or person trained and experienced	Person trained and experienced

SCAMPI-A SCAMPI-B SCAMPI-C

References: "A Quantitative Comparison of SCAMPI A, B, and C," R. Hefner and D. Luttrell, CMMI Technology Conference and User Group, 2005

Hefner, "Lower Cost, More Effective Alternatives to SCAMPIs", 2007

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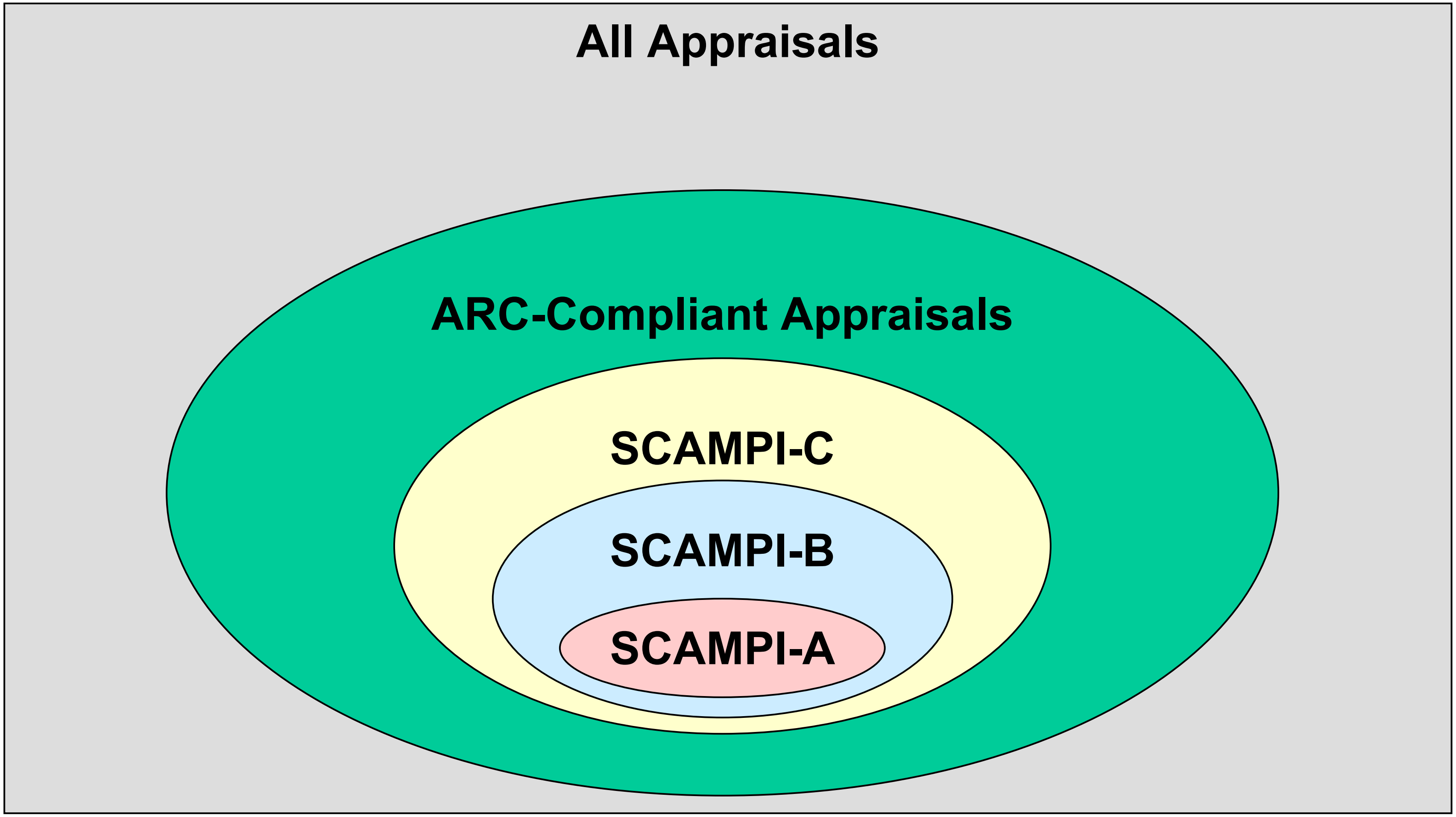
A Variety of Appraisals



Hefner, "Lower Cost, More Effective Alternatives to SCAMPIs", 2007

What's Important About ARC Compliance?

> The appraisal principles for the CMMI Product Suite are similar to those for appraisals using the Capability Maturity Model for Software and Systems Engineering Capability Model:
>
> - Start with an appraisal reference model.
> - Use a formalized appraisal process.
> - Involve senior management as the appraisal sponsor.
> - Focus the appraisal on the sponsor's business objectives.
> - Observe strict confidentiality and non-attribution of data.
> - Approach the appraisal collaboratively.
> - Focus on follow-on activities and decision-making based upon the appraisal results.
>
> *- ARC, v1.2*

- ***In what situations would these principles not be appropriate?***
  - Sponsor desire for an informal appraisal process
  - Non-attribution not critical
  - Inability/no desire to work collaboratively

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What's Important About SCAMPI-A Compliance?

The Standard CMMI Appraisal Method for Process Improvement (SCAMPI) is designed to provide benchmark-quality ratings relative to Capability Maturity Model Integration (CMMI) models.

SCAMPI A enables a sponsor to

- gain insight into an organization's capability by identifying the strengths and weaknesses of its current processes
- relate these strengths and weaknesses to the CMMI reference model(s)
- prioritize improvement plans
- focus on improvements (correct weaknesses that generate risks) that are most beneficial
- to the organization given its current level of organizational maturity or process capabilities
- derive capability level ratings as well as a maturity level rating
- identify development/acquisition risks relative to capability/maturity determinations

- SCAMPI A, v1.2

- **SCAMPI-A appraisals were designed to:**
  - Be accurate (collaboration of multiple sources – direct, indirect, written/face-to-face affirmations, trained team, authorized team leader)
  - Achieve organizational buy-in (collaborative approach, construction of PIIDs, interviews, draft findings)
- ***In what situations would this not be appropriate?***

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How Do SCAMPI-B and -C Relate?

> These methods can form building blocks for a progression of appraisals – for example, starting with a SCAMPI C reviewing the process descriptions, then a SCAMPI B investigating their deployment to projects, finally leading to a formal benchmarking event focused on institutionalization of the practices across the organization.
>
> *-- Handbook for Conducting Standard CMMI Appraisal Method for Process Improvement (SCAMPI) B and C Appraisals, Version 1.1*

- **But all SCAMPI appraisals share the same basic methods (interviews, evidence review, team qualifications) and reflect similar objectives (accuracy, buy-in)**
- **The typical SCAMPI C/B/A sequence works well for an organization starting a process improvement effort, i.e., no defined processes**
- **May not work as well for an organization that has existing processes, and whose main issue is project adoption**

Hefner, "Lower Cost, More Effective Alternatives to SCAMPIs", 2007

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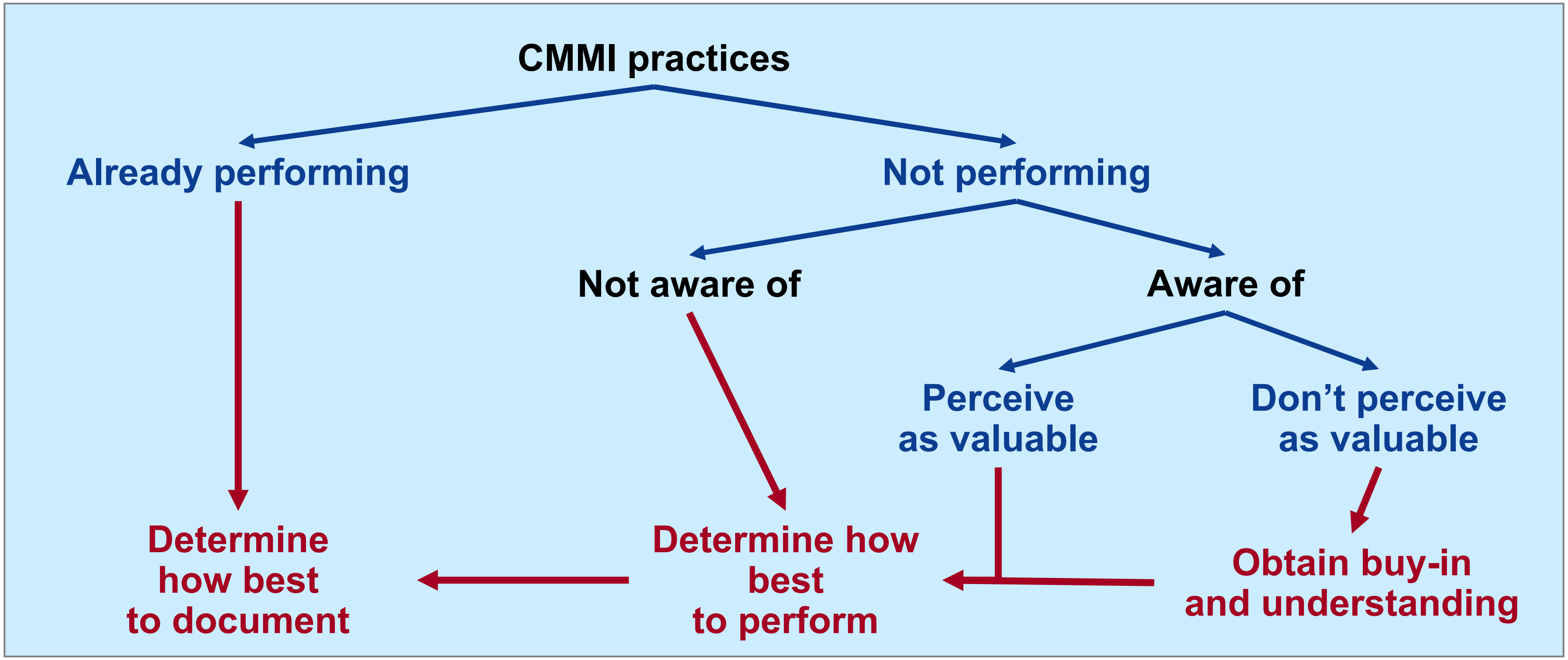
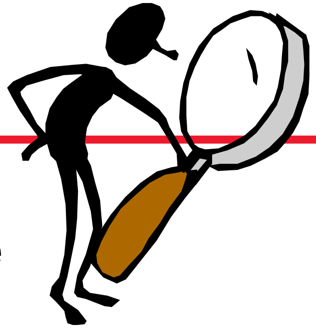
Adopting the CMMI



- **Key enablers**
  - Willingness to learn unfamiliar practices
  - Desire to extract value rather than "check the box"
  - Ability to interpret the CMMI in your context
  - Access to experts

Hefner, "Lower Cost, More Effective Alternatives to SCAMPIs", 2007

Effective Use of Audits and Appraisals



- **Process and product audits provide tangible, objective measures of adoption/sustainment**
  - Policies, processes, and standards must reflect the desired behaviors
- **Appraisals evaluate the effectiveness of the audit program**
  - Standardized tools, approaches, and methods
  - Consistency of appraisers – if they understand the way we are structured and operate, there is less time required to understand what we are doing.
  - Pre-appraisal activities to prepare projects for the appraisal process
- **The frequency of audits and appraisals, and the sampling, must reflect the progress of the cultural change**
  - As the culture begins the change, more frequent and more in-depth audits/appraisals are required
  - Later, the amount of audits/appraisal may decrease, if the culture has truly changed

"Sustaining CMMI Compliance ," R. Hefner, CMMI Technology Conference and User Group, 2006

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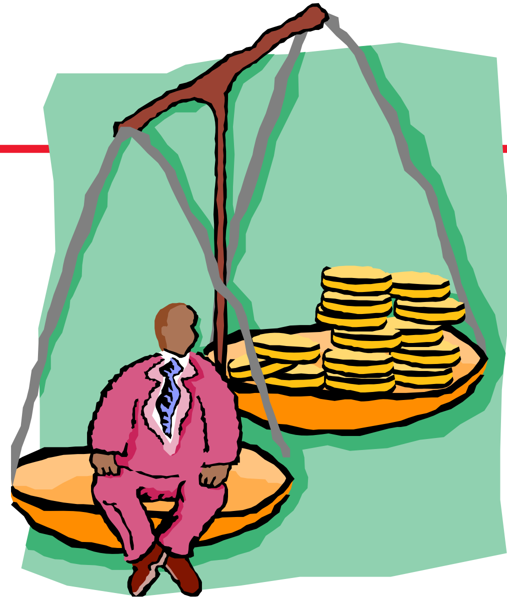
Hefner, "Lower Cost, More Effective Alternatives to SCAMPIs", 2007

Where Could We Save Money?



- **Could we ignore/relax some of the ARC requirements?**
  - Use an undocumented method
  - Use an untrained team
  - Less preparation of participants
  - Less involvement of participants
  - Less corroboration of evidence
- **Could we use different approaches than SCAMPI uses?**
  - Assist projects in evidence gathering
  - Don't require consensus among appraisers
  - Use a different rating scheme (or no ratings)
  - Use different objectives than practice compliance (efficiency, effectiveness, consistency, understanding/awareness, etc.)

Hefner, "Lower Cost, More Effective Alternatives to SCAMPIs", 2007

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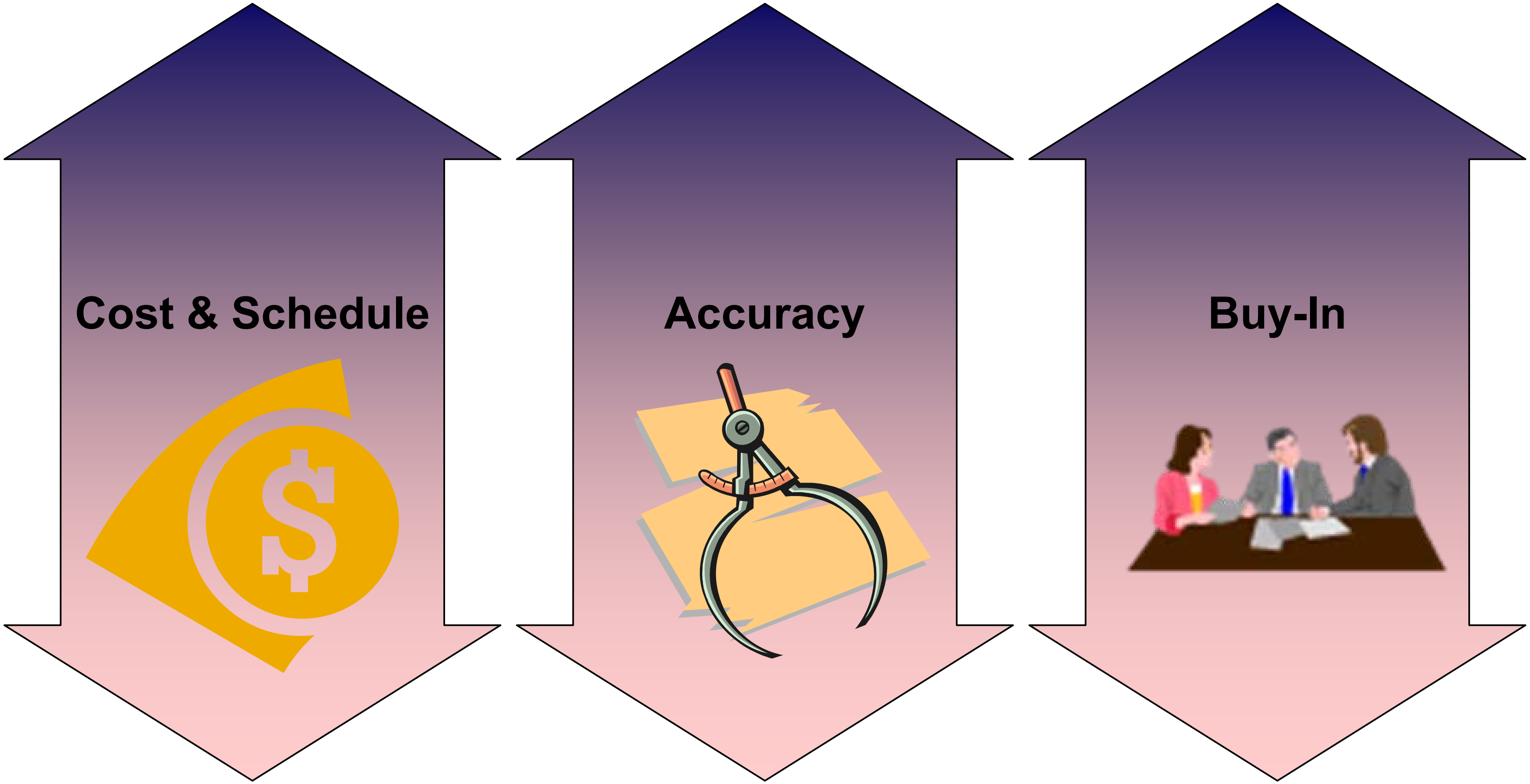
Impacts

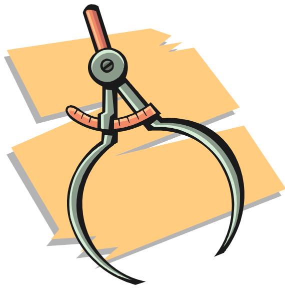


"A Quantitative Comparison of SCAMPI A, B, and C," R. Hefner and D. Luttrell, CMMI Technology Conference and User Group, 2005

Hefner, "Lower Cost, More Effective Alternatives to SCAMPIs", 2007

Minimum Team Size

- **Cost is composed of:**
  - Team costs – goes up with team members
  - Organizational costs (interview, presentations) – largely fixed regardless of size



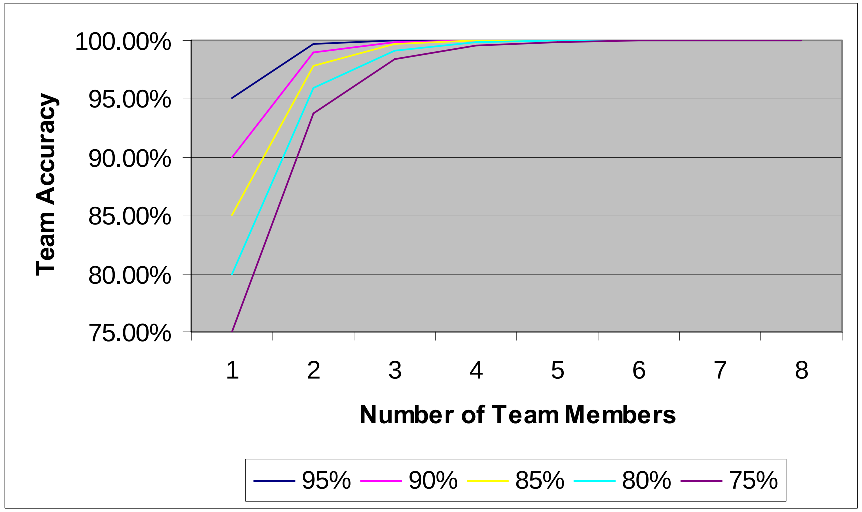
- **Accuracy goes up with as team size increases**

- **Buy-in is driven by the confidence the organization's members has in the appraisal process and appraisal team**
  - Larger teams can increase the likelihood that a respected person is on the team

Hefner, "Lower Cost, More Effective Alternatives to SCAMPIs", 2007

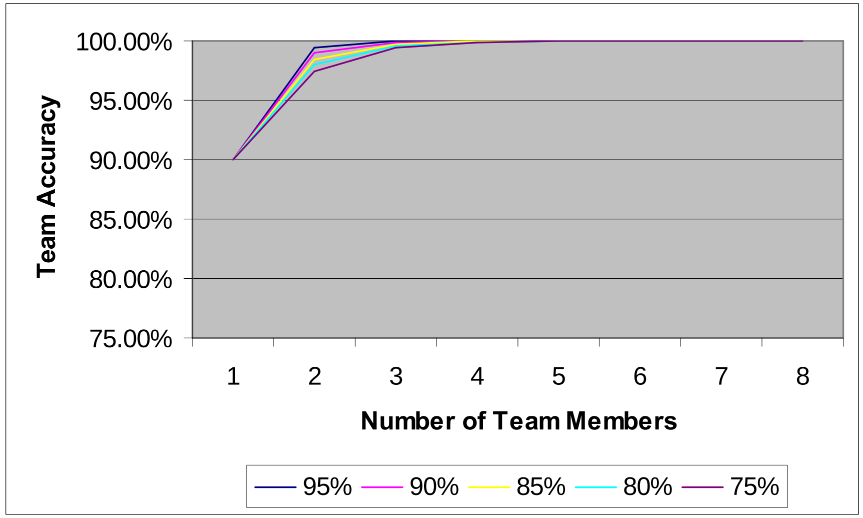
Team Accuracy vs. Team Size

- **Team accuracy vs. team size, for given individual accuracies**



- **As team size goes up, team accuracy rapidly increases (assuming the right answer is obvious once presented)**
- **Teams of greater than 4 provide little increase in accuracy**

- **Same, assuming 90% leader accuracy**



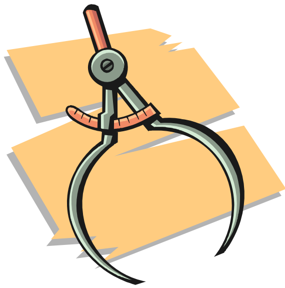
- **If the team leader is 90% accurate, additional team members add little accuracy**
- **Adding team members does give a chance for them to learn**

Appraiser accuracy, not team size, is critical

Hefner, "Lower Cost, More Effective Alternatives to SCAMPIs", 2007

Sources of Objective Evidence

- **Evidence review takes 1-2 times the length of interviews**
  - If evidence is not reviewed, easy to answer “correctly” in the interviews
  - If interviews are not conducted, evidence may be faked (not really in use) - normally easy to spot



- **Accuracy increases significantly with evidence review**
- **Validation takes little time and often increases accuracy 20-30%**

- **Buy-in is greatly increased by validation**
  - Nothing decreases buy-in faster than a “weakness” that everyone knows is wrong

Hefner, "Lower Cost, More Effective Alternatives to SCAMPIs", 2007

The Workshop Concept

- **Objectives:**
  - Determine current gaps relative to project compliance with CMMI
  - Map existing evidence to CMMI
  - Determine effective ways to perform and/or document practices
  - Raise awareness of project personnel, build buy-in
- **Process:**
  1. Train projects on CMMI terminology and structure (1-3 day)
  2. Projects complete PIIDs mapping of their existing evidence, self-assess practice and evidence gaps
  3. A CMMI expert walks a group of projects through the model. For each practice, the expert:
     - Describes the practice and typical evidence
     - Reviews each project's evidence for acceptability
     - Identifies practice gaps and discusses possible solutions
     - Identifies documentation gaps and possible solutions

Hefner, "Lower Cost, More Effective Alternatives to SCAMPIs", 2007

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Summary

- As a set, the SCAMPI methods provide a powerful set of tools to use in CMMI adoption
- However, there are some situations in which these three methods are not appropriate, or are not cost-effective
- Improvement professionals should consider the full range of options available to them, and select the tools and methods best suited to the needs of the sponsor

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DEFINING THE FUTURE

Using Workshops to Speed CMMI Adoption and Evidence Gathering

CMMI Technology Conference & User Group
12-15 November 2007

Rick Hefner, Gwynn Pyle,
Michael Sturgeon, Janice Tauser
Northrop Grumman Corporation
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Background

- **The hardest part of implementing CMMI-based improvements is getting projects to understand and perform the practices**
- **Workshops can be an effective mechanism for:**
  - Raising awareness and buy-in
  - Developing a deeper understanding of the practices
  - Ensuring they are properly implemented by the project personnel
- **This presentation will explain how to plan and conduct CMMI workshops, based on the proven methods used by Northrop Grumman in achieving Level 5 across 13 organizations**

Topics

- When the typical SCAMPI C/B/A sequence doesn't work
- The workshop concept
- How to scope and plan the workshop
- Choosing workshop participants
- Identifying the "right" evidence
- Additional opportunities
- Dealing with resistance and lack of buy-in
- Workshop follow-up
- Sustaining senior management support
- Lessons Learned

Characteristics of CMMI Appraisal Classes

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SCAMPI-A **SCAMPI-B** **SCAMPI-C**

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When the Typical SCAMPI C/B/A Sequence Doesn't Work

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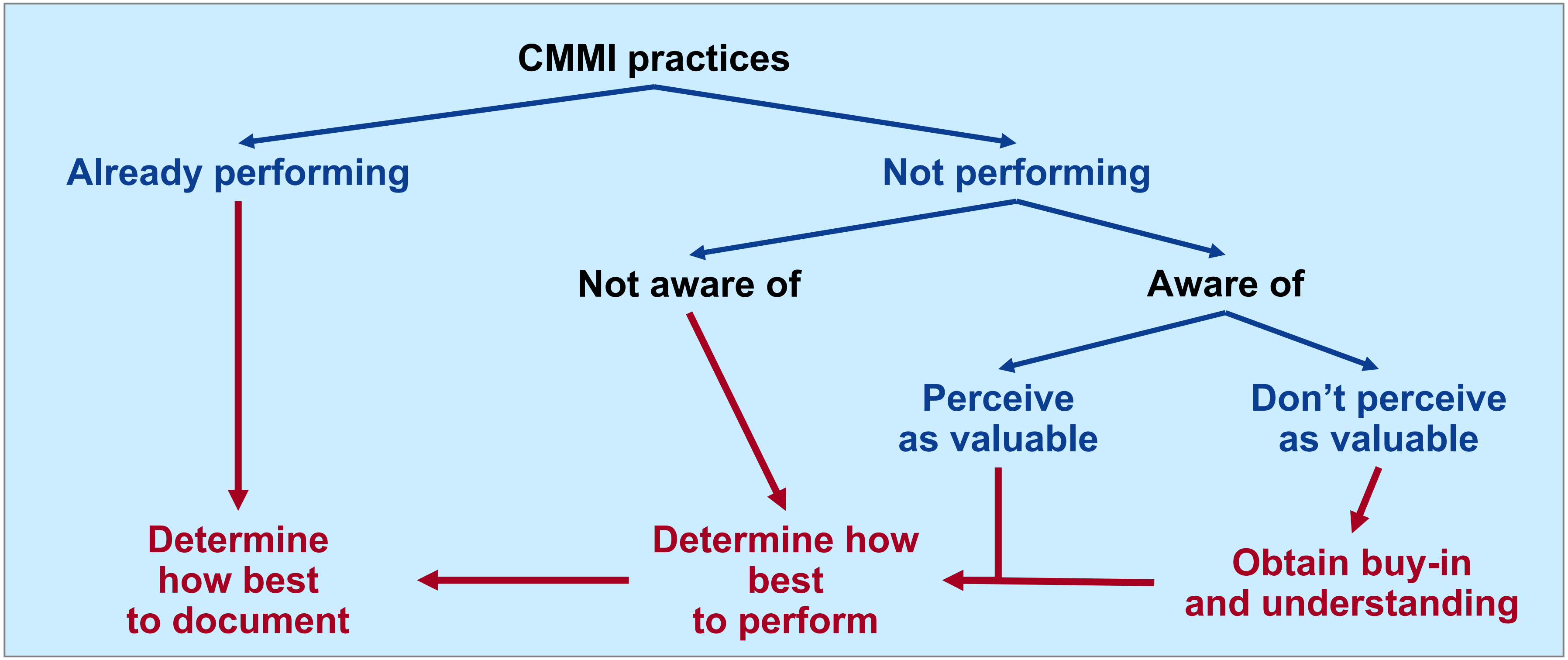
Adopting the CMMI



- **Key enablers**
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"Using Workshops to Speed CMMI Adoption and Evidence Gathering", 2007

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How To Scope And Plan The Workshop

- **Several projects can participate at the same time**
  - Explain once to many projects, build off each other's questions
  - Can use projects who are performing the practice, or documenting properly as examples
  - Peer pressure
- **Having multiple projects means:**
  - More frequent context switching by the CMMI expert
  - More logistics
- **Best practices**
  - CMMI expert should become familiar with each project's context, terminology
  - One process area per session with process area performers
  - Front screen display of the PIIDs table
  - Each project uses a separate computer for their PIIDS, evidence display

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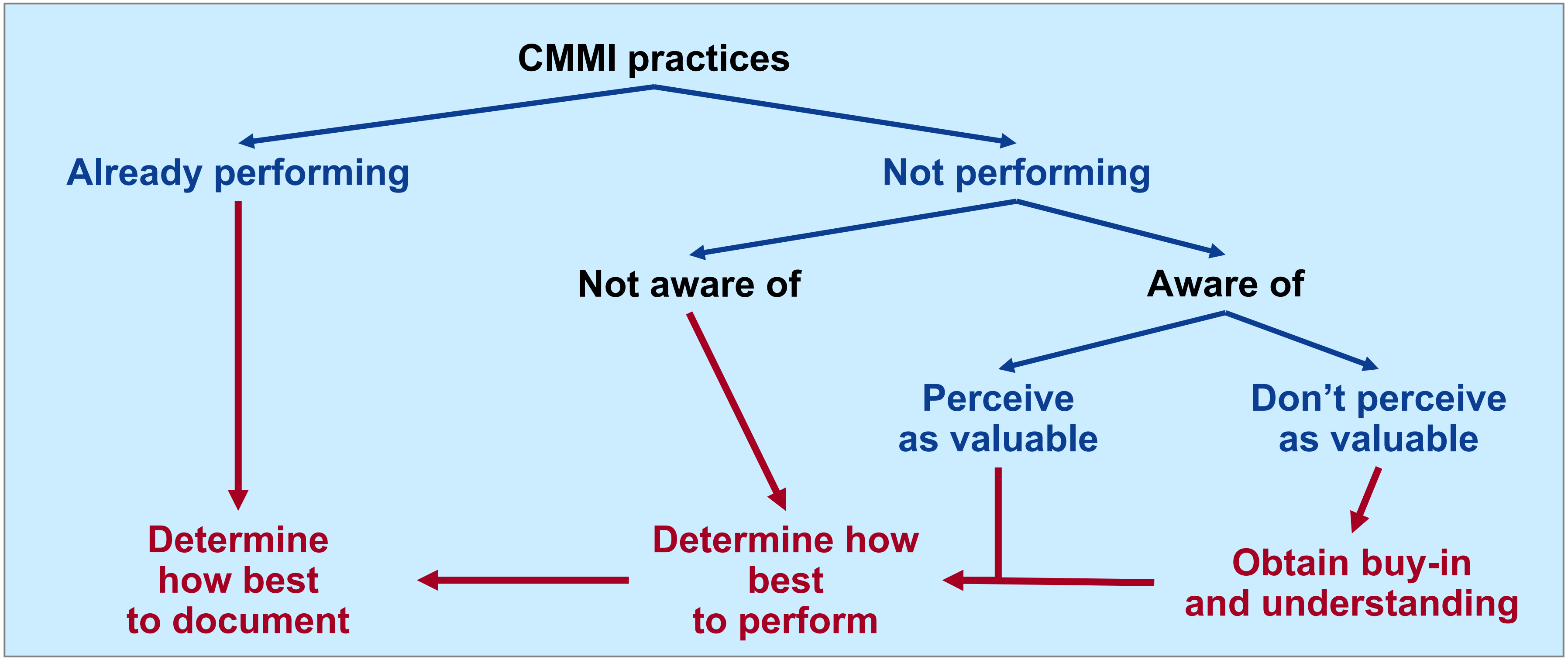
Choosing Workshop Participants



- **The performer(s) of the process should be present**
  - Explain implementation and evidence
  - Explain context and project culture (e.g., barriers)
  - If practice is not currently being performed, discuss the value of the practice, and possible approaches that might be value-added
  - If practice is being performed but not documented, discuss possible documentation approaches that fit the culture

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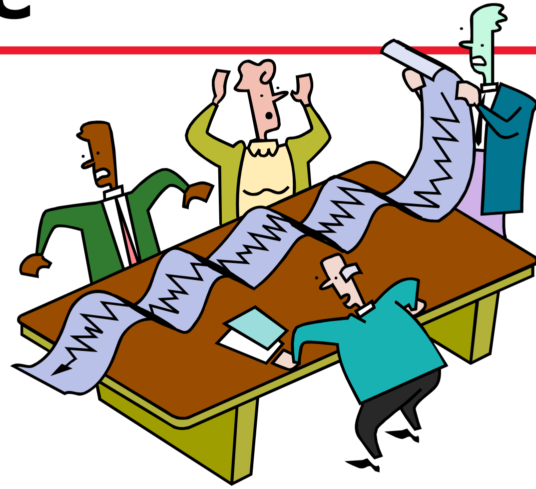
Identifying The Right Evidence



- **Because so much of the focus is on finding direct evidence for each practice, it is easy to forget that the objective is <u>improving the process</u>**
- **Challenges**
  - Bring Me a Rock
  - “If our document said ___________, would that be enough?”
  - Documenting for the appraisers, not the project personnel
- **Remember: the purpose of plans and processes is to provide guidance to the project personnel**
  - Appraisers can suggest what items should be covered
  - Adequacy is determined by whether <u>project personnel</u> understand what to do

Additional Opportunities

- **Can conduct simultaneous quality assurance process audits**
  - Appraise against the projects defined process (which probably includes all the CMMI practices)
  - Educate the QA staff on the proper approach to an audit, and the terminology/meaning of the CMMI practices
- **Can look for other process improvement opportunities beyond CMMI compliance**
  - Consistency across the organization
  - Identification of best practices
  - Efficiency, effectiveness
  - Need for tools, templates, training

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Dealing With Resistance And Lack Of Buy-in

- **Workshops offer a great opportunity to gauge project understanding and buy-in to the improvement effort**
  - Do the project personnel make a honest effort to map their evidence?
  - Do they show up on time and prepared?
  - Do they appear engaged in determining solutions?
  - Are they looking to improve their processes, or just satisfy the appraisers?
  - What factors are preventing their complete commitment (time, knowledge, management encouragement, etc.)

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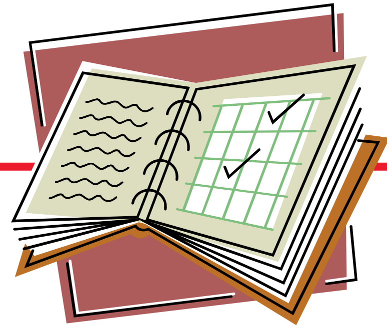
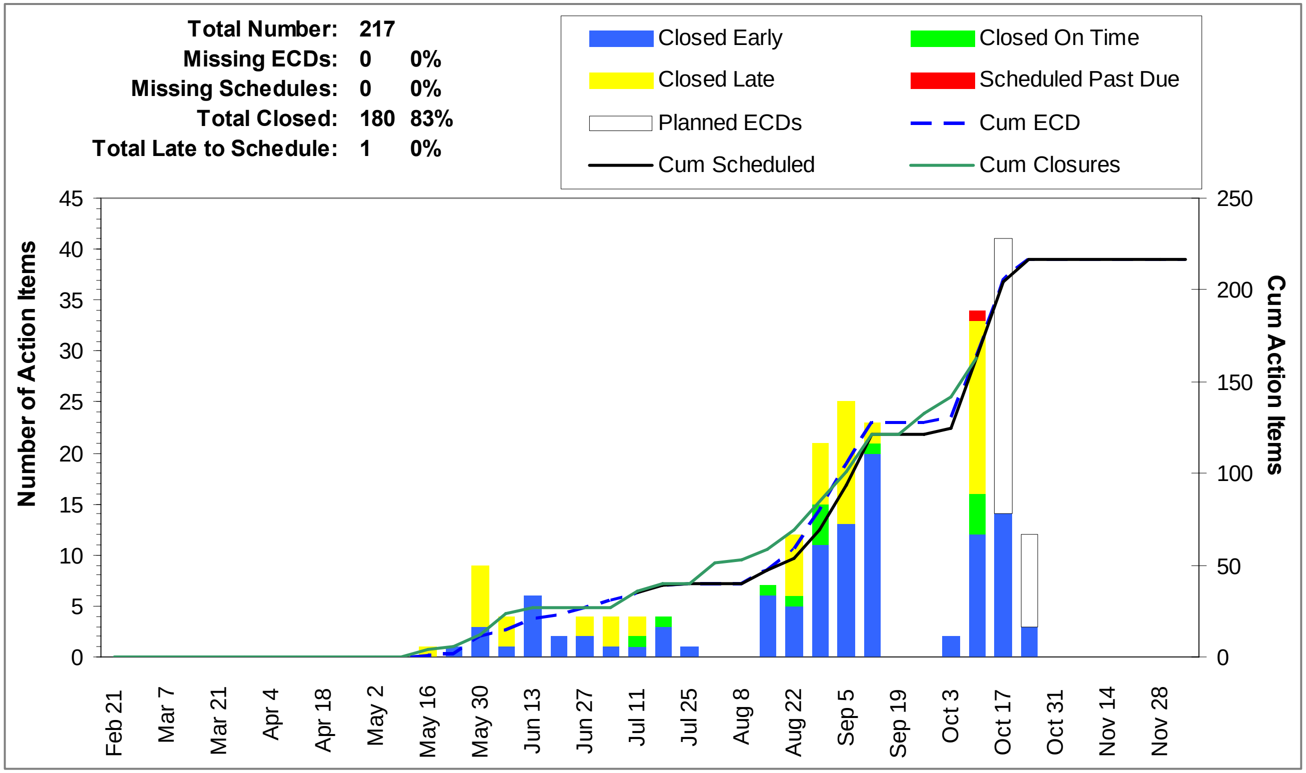
Workshop Follow-up



- **Each workshop results in**
  - A set of practice gaps and proposed approaches (start doing this)
  - A set of documentation gaps and proposed approaches (start documenting what we are currently doing like this)
- **These should be converted into a set of actions and timelines**
  - When will the evidence exist, so we can re-assess?
- **Tracking against this timeline will tell you when you will be ready for another workshop and eventually, a more formal appraisal**
  - A second group session is sometimes useful
  - Isolated gap closures can be handled one-on-one

Sustaining Senior Management Support

- **Senior management should be kept appraised of progress and barriers to achieving their goals**
  - Number of current gaps and rate of closure
  - Common gap areas
  - Opportunities beyond CMMI compliance
  - Resistance



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"Using Workshops to Speed CMMI Adoption and Evidence Gathering", 2007

Lessons Learned

- **The hardest part of implementing CMMI-based improvements is getting projects to understand and perform the practices**
- **Workshops can be an effective mechanism for:**
  - Raising awareness and buy-in
  - Developing a deeper understanding of the practices
  - Ensuring they are properly implemented by the project personnel
- **Engaging with the projects, and understand their barriers to improvement, is the true spirit of process improvement**

Transdyne Corporation
CMMI Implementations in Small & Medium Organizations
SEI ID No. 0100145-01

Benefits of SCAMPI Class C in Small ï Medium Organizations

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nefits of SCAMPI Class C in
um Organizations

- Process Improvement Factors in Small ï Medium Organizations
- Overview of Process Areas and Representations
- Context for SCAMPI Class C Benefits for Small ï Medium Organizations
- Process Improvement Scenarios in Small ï Medium Settings:
- SCAMPI Family of Appraisals Strategy Map
- SCAMPI C Benefits for Small ï Medium Organizations
- Comparison of CMMI Implementation Success Factors and Organization Size

...vement Success Factors in ...m Organizations

Transdyne Corporation
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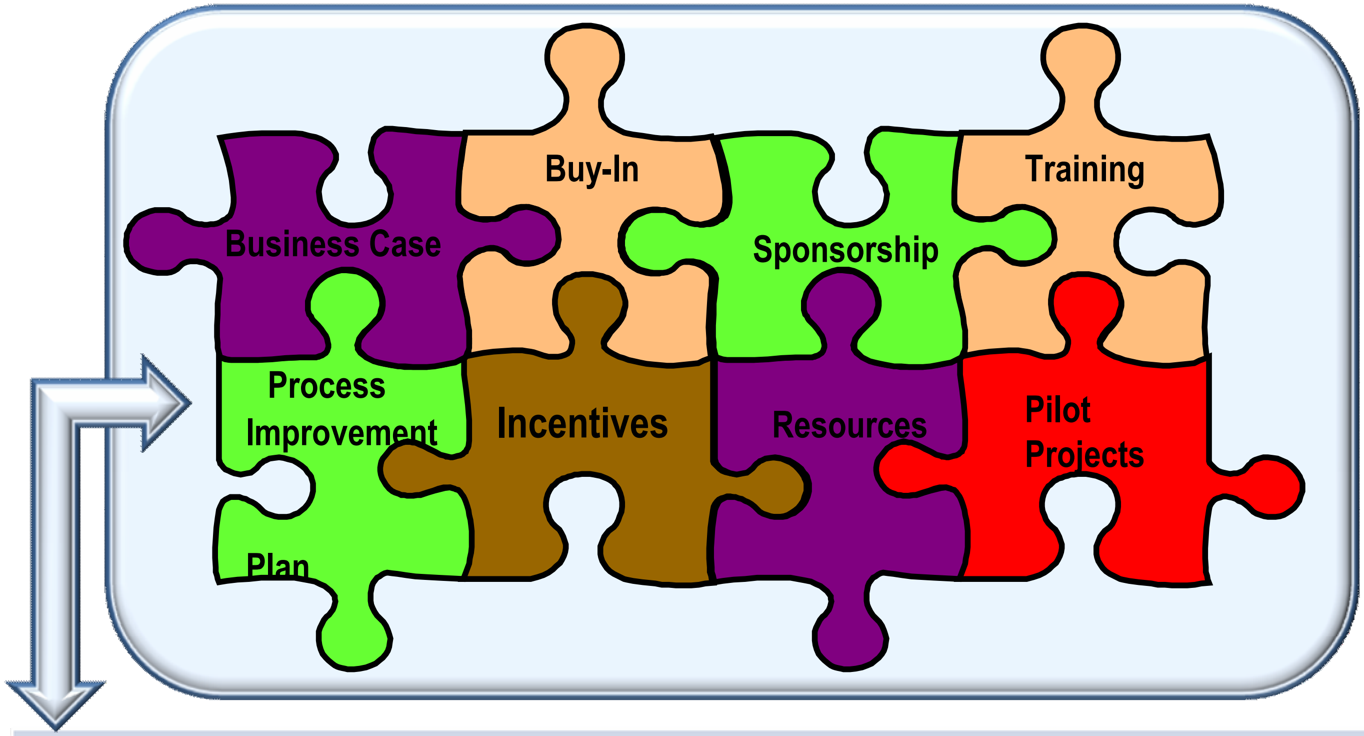
Overview of CMMI v1.2 for Small & Medium Organizations



Success Factors in Small – Medium Organizations	
Simpler organization structure	Efficient communication skills
Flexible processes	Depth of understanding of business goals
Staff involvement and receptiveness to new ideas	Awareness of existing processes
Process variance simpler to control	Less diversity in products & services

l Importance: The Usefulness of Models

"All models are wrong, but some are useful."

George Box
(Quality and Statistics Engineer)

Å **A CMMI model is not a process.**

Å **A CMMI model describes the characteristics of effective processes.**

um Organization Perspective: CMMI v1.2 Process Areas (PAs)

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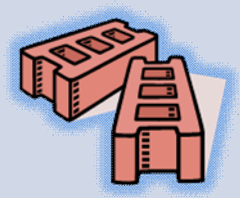
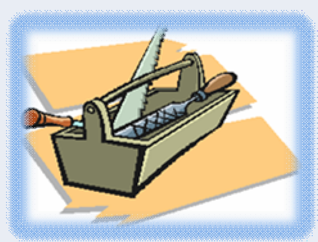
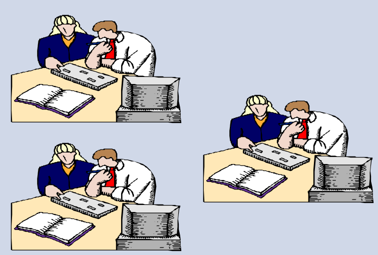
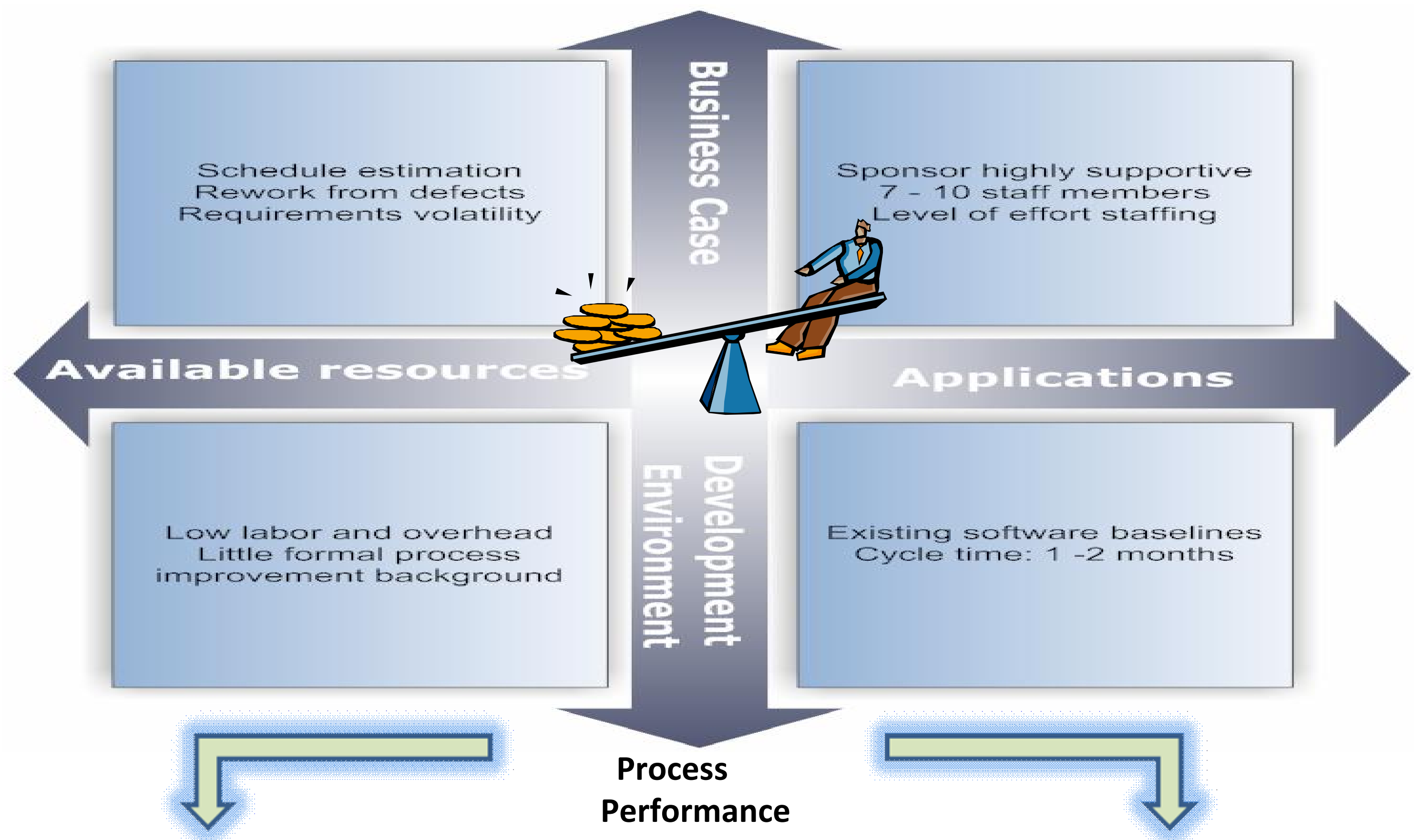
CMMI Implementations in Small & Medium Organizations

Process Area	Benefits
1. Function  	The Process Areas are used as building blocks to construct a foundation for improving process performance.
2. Purpose 	The practices in the PAs provide organizations a set of proven management tools that are non-prescriptive (never a set of implementation practices).
3. Implementation  	Each organization should determine how to implement these practices within their organizations always from a pragmatic, **"what makes sense" perspective.**

SCAMPI Class C Benefits for dium Organizations

	**These benefits of formal process improvement activities and SCAMPI Class C appraisals are more applicable to small and medium organizations than larger corporations.**
	The small to medium organizations often function as suppliers of specialized technical services or products.
	These benefits of SCAMPI C appraisals are from a sample of small to medium organizations that continued their process improvement journeys by conducting a SCAMPI B and planning a Class A .

rovement Scenarios in um Settings



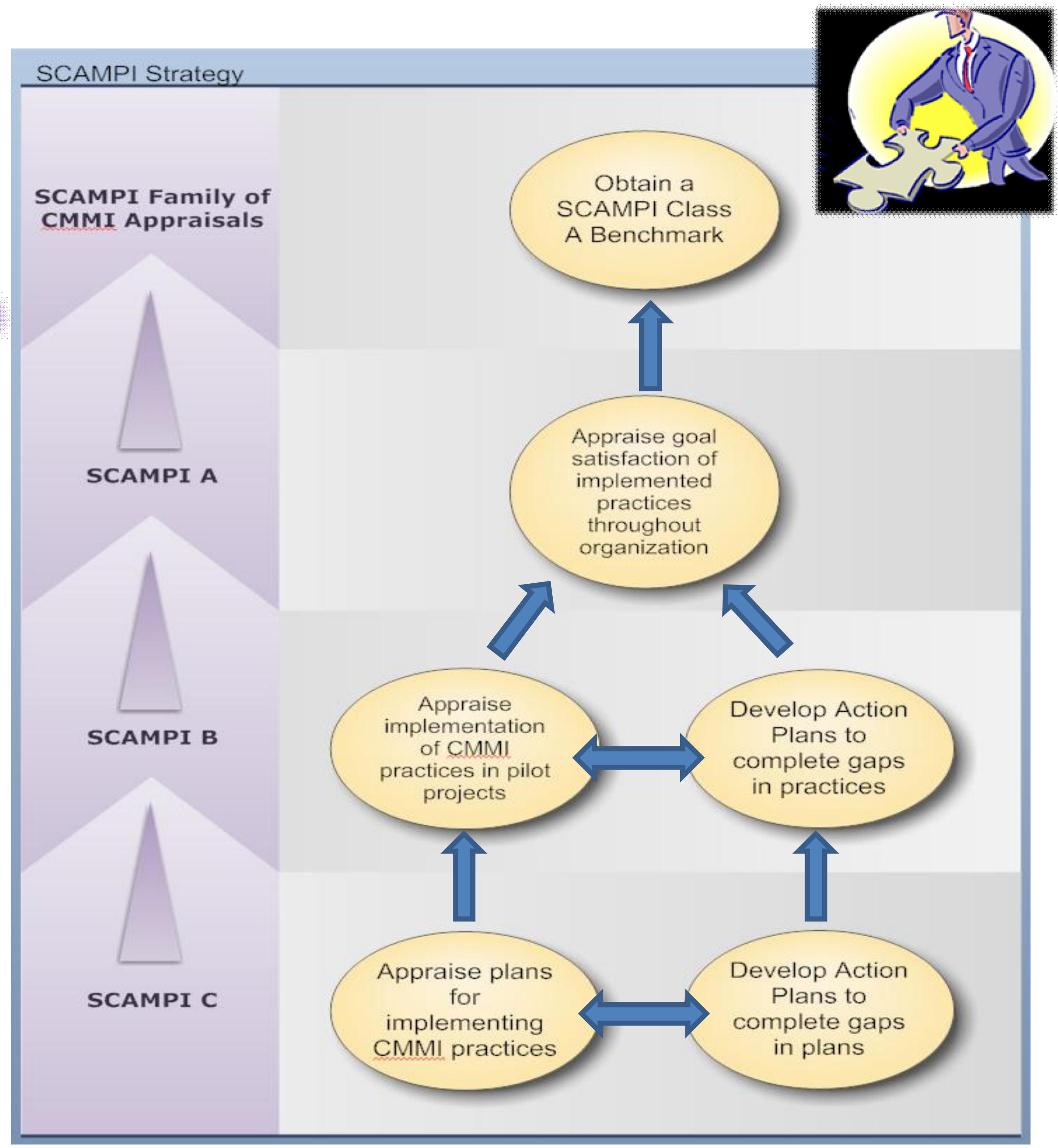
Process Performance Intervals

-6.0% < Staff Size Accuracy < 9.0%
0% < Invoice Accuracy < 6.5%

0 < Latent Defects < 3
0 < Latent Defects < 1

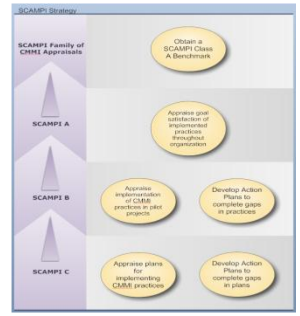
4.5 < Customer Satisfaction < 5.0
-8 days < Scheduling Accuracy < 8 days

amily of Appraisals Strategy Map



A key activity in obtaining a SCAMPI benchmark is applying the risk management functions of SCAMPI Class C and B appraisals **before** scheduling a Class A benchmark.

efits for
n Organizations



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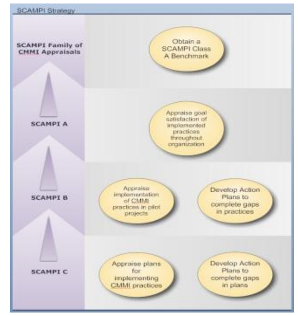
CMMI Implementations in
Small & Medium Organizations

CMMI Implementation Success Factors	small settings		large organizations
flatter organization	✓		
efficient communication skills	✓		
flexible processes	✓		
depth of understanding of the business goals	✓		
staff involvement	✓		
staff receptiveness to new ideas	✓		
awareness of existing processes	✓		
simpler process performance models	✓		
process variance simpler to control	✓		
less diversity in products and services	✓		

Success Factor	Benefits of SCAMPI C
Flatter organization	Less management levels in planning
	Increased visibility
	Increased staff interactions
	More efficient buy-in
Efficient communication skills	Increased sponsor commitment

fits for Small ï Medium ontinued)



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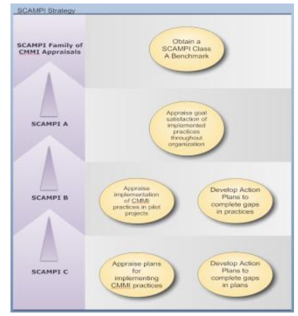
process variance simpler to control	✓		
less diversity in products and services	✓		

Success Factor	Benefits of SCAMPI C
Flexible processes	Early identification of improvements are less challenging to implement in existing processes. Institutionalization cycles are usually shortened.
Depth of understanding of business goals	Documentation of process improvement goals increases staff awareness of business goals and impact on profitability
Staff involvement	Few staff members are often ñownersò of key processes. Staff members may wear ñmany different hatsò in SCAMPI Class C.

Benefits for
ium Organizations



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CMMI Implementations in
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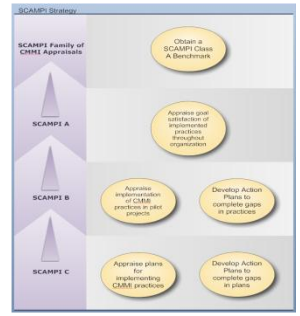
process variance simpler to control	☑		
less diversity in products and services	☑		

Success Factor	Benefits of SCAMPI C
Staff receptiveness to new ideas	Early identification of improvements are less challenging to implement.
Awareness of existing processes	Single staff members are the process ñownersòand understand the process.
Simpler process performance models 	Existing processes usually have a measurement baseline established and rely on some type of forecasting to improve survivability.

…efits for …n Organizations (continued)



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simpler process performance models	☑		
process variance simpler to control	☑		
less diversity in products and services	☑		

Factor	Benefits of SCAMPI C
Process variance simpler to control	User templates are less complex to develop and implement.
Less diversity in products and services	The organizational scope of a SCAMPI Class C is easier to focus on the part of the organization that is expanding.

parison of CMMI Implementation s and Organization Size

CMMI Implementation Success Factors	small settings		large organizations
flatter organization	☑		
efficient communication skills	☑		
flexible processes	☑		
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awareness of existing processes	☑		
simpler process performance models	☑		
process variance simpler to control	☑		
less diversity in products and services	☑		

Small & medium organizations are not "miniatures" of large corporations!

Smaller organizations provide a conducive environment to implement CMMI practices due to:

1. simplicity of organizational structure
2. efficient communications
3. staff receptiveness of new ideas
4. depth of awareness of the processes
5. easier to minimize variance in performing key processes

The End

You have just seen

Benefits of SCAMPI Class C for small – medium organizations from the "30,000 feet" level.

Questions or Comments ?

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Not Just for Software Anymore

Lessons Learned from a CMMI™ Appraisal on Projects in a Nuclear Weapons Facility

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Jeanie Kitson, SCAMPI Lead Appraiser
Phone: 412-889-5918
Email: kamolkj@mindspring.com

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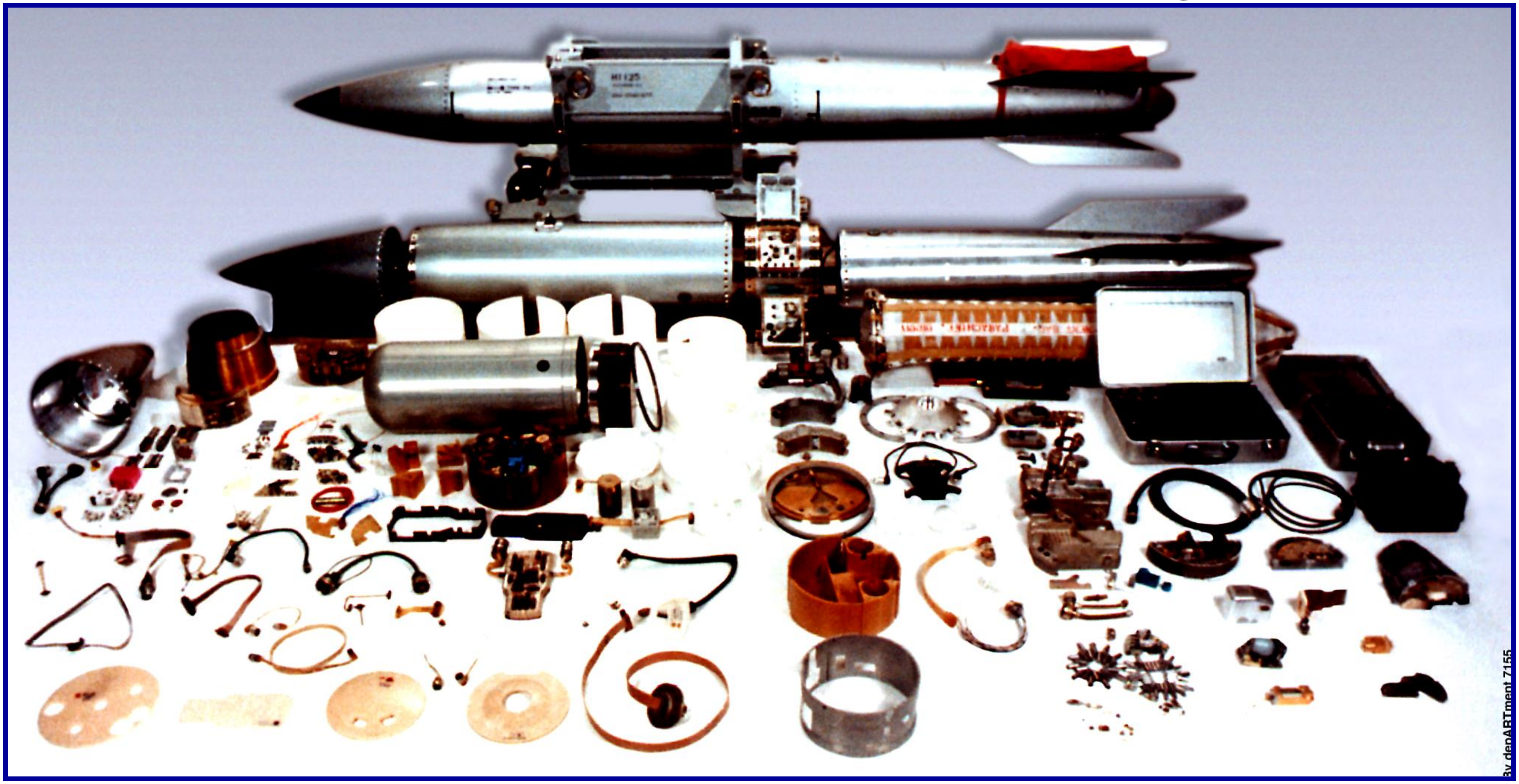
CMMI for Construction Projects

- Organizational Overview
- Why CMMI?
- CMMI Implementation
  - Methodology
  - Tools
  - Unique Challenges
- Appraisal Results

Complex Products



Responsible for 85% of nuclear weapon components

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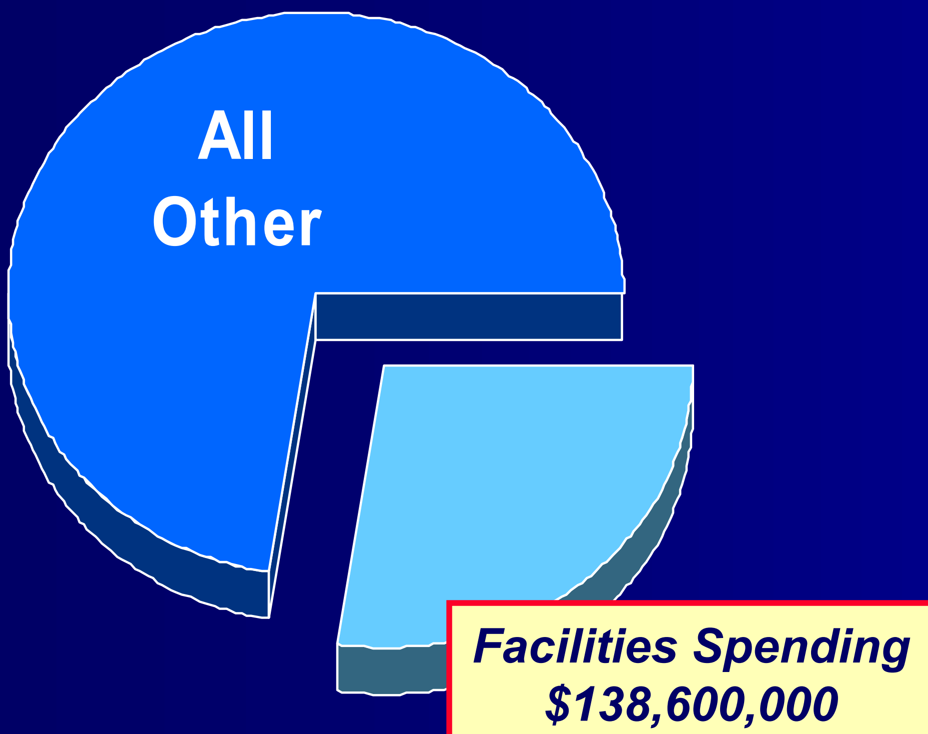
KCP Funding



Readiness in Technical Base & Facilities (RTBF)

Å Construction Projects

Å Production Capital purchase and install

Å Maintenance

Å Infrastructure

Å Utilities

Everything from Semiconductors to Semi-trailers

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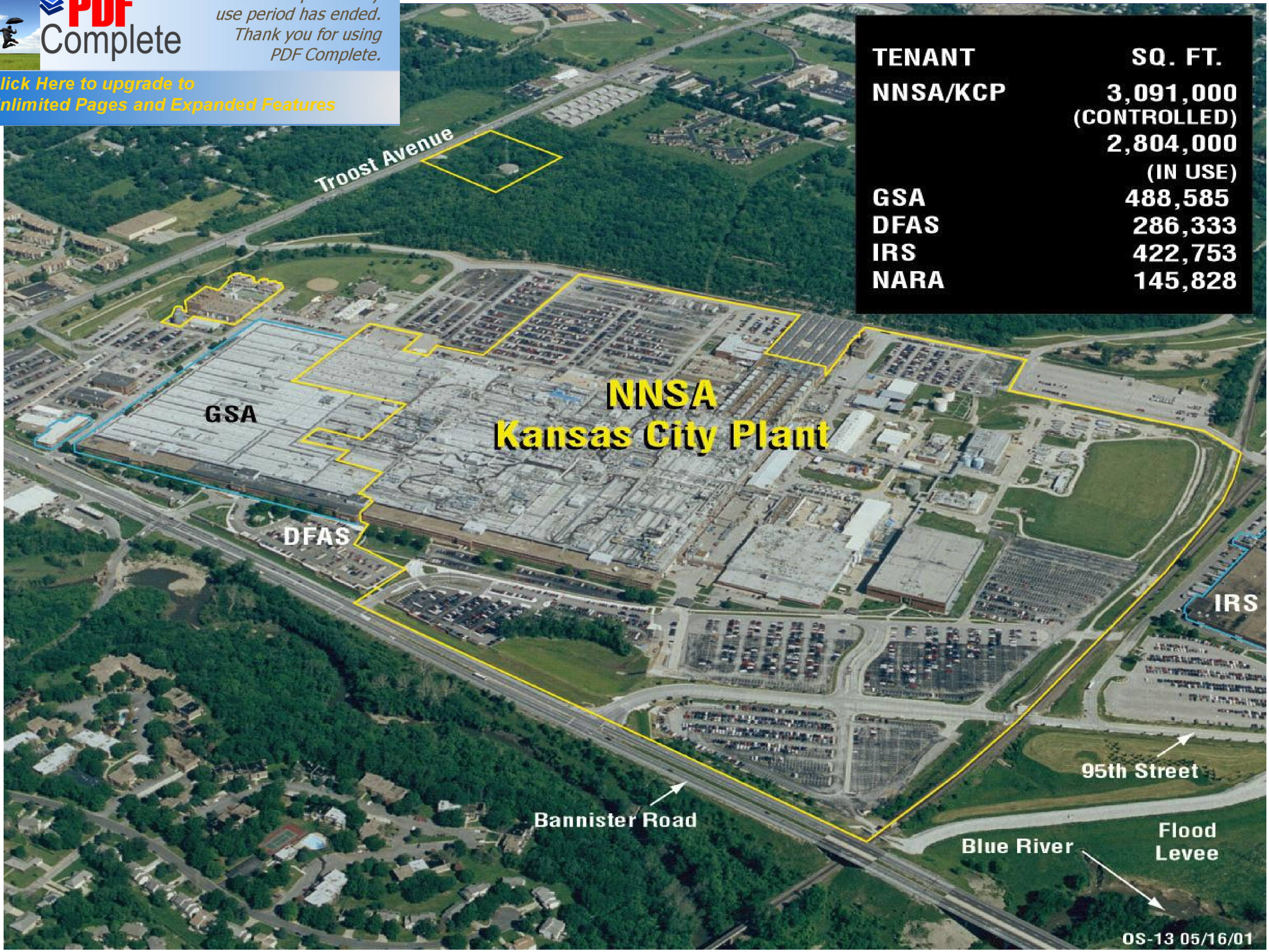
Infrastructure Overview

- 140 Acres of a 300 Acre Federal Complex shared with GSA, IRS
- 40 Buildings (3.1 Million square feet under 30 acres of roof)
- 13 Acres of Parking Lots and 16 Miles of Roadways
- Over 600 air handling units
- Over 27,000 pieces of Capital Equipment
- Mechanical, Electrical, and Special Manufacturing



TENANT	SQ. FT.
NNSA/KCP	3,091,000 (CONTROLLED) 2,804,000 (IN USE)
GSA	488,585
DFAS	286,333
IRS	422,753
NARA	145,828

Project Context:

Å 1-2 “Large” authorized projects annually (>$10M), high oversight

Å 3-5 “Medium” authorized projects annually ($1M-$10M), high oversight

Å 500-600 “Small” projects (<$1M) no oversight, annual cost $15-$20M

Why Change?

Å Failure on $125M project (RSKM)

Å Growing focus on “small” projects (2005)

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Why CMMI?

- Evaluated 4 competing project evaluation models . . .
  - ISO (base case)
  - OPM3 (published by Project Management Institute – PMI)
  - CMMI ver 1.2
  - Kersner[1] (proprietary published model)
- . . . Against 5 criteria:
  - Credibility and wide-use in industry
  - Identifies crisp and actionable items
  - Holistic and systematic
  - Cost to evaluate and maintain
  - Proven correlation to business improvement

[1]Using the Project Management Maturity Model, 2nd edition, 2005, Harold Kerzner, PhD, ISBN 0-471-69161-5

Alternative Analysis

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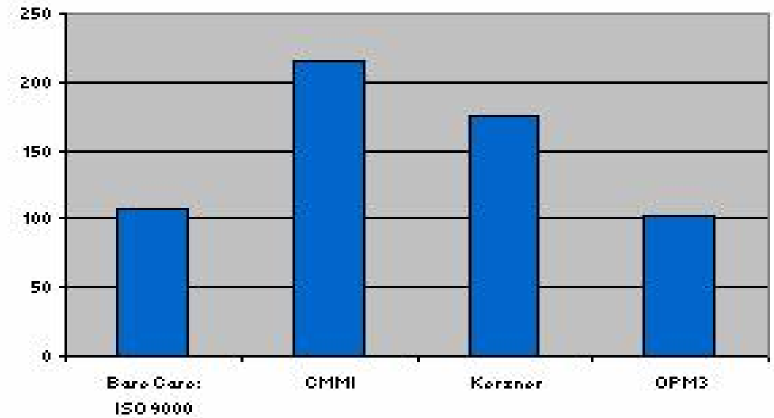

Goals \ Concepts	WF	Base Case: ISO 9000	CMMI	Kerzner	OPM3
1. The model is accepted and credible and used widely in commercial industry	10	3	3	3	1
2. The model identifies crisp and actionable improvements	8	3	9	7	5
3. The model drives a holistic and systematic approach to driving enterprise improvements	7	3	9	5	1
4. Cost to evaluate/implement/sustain	6	3	1	5	5
5. The model has a proven/demonstrated correlation to improved enterprise results.	5	3	9	5	3
Totals		15	31	25	15
Wghted Totals		108	216	176	102

Appraisal Scope using Continuous Representation

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Risk Management was important to the NNSA customer and had been a focus of the organization for the previous years.

The Continuous Representation allowed the flexibility to include RSKM in the appraisal.

Category	Process Areas
Process Management	Organizational Process Focus Organizational Process Definition Organizational Training Organizational Process Performance Organizational Innovation and Deployment
Project Management	**Project Planning** **Project Monitoring and Control** **Supplier Agreement Management** Integrated Project Management **Risk Management** Quantitative Project Management
Engineering	**Requirements Management** Requirements Development Technical Solution Product Integration Verification Validation
Support	**Configuration Management** **Process and Product Quality Assurance** **Measurement and Analysis** Causal Analysis and Resolution Decision Analysis and Resolution

tegrated Process Flow

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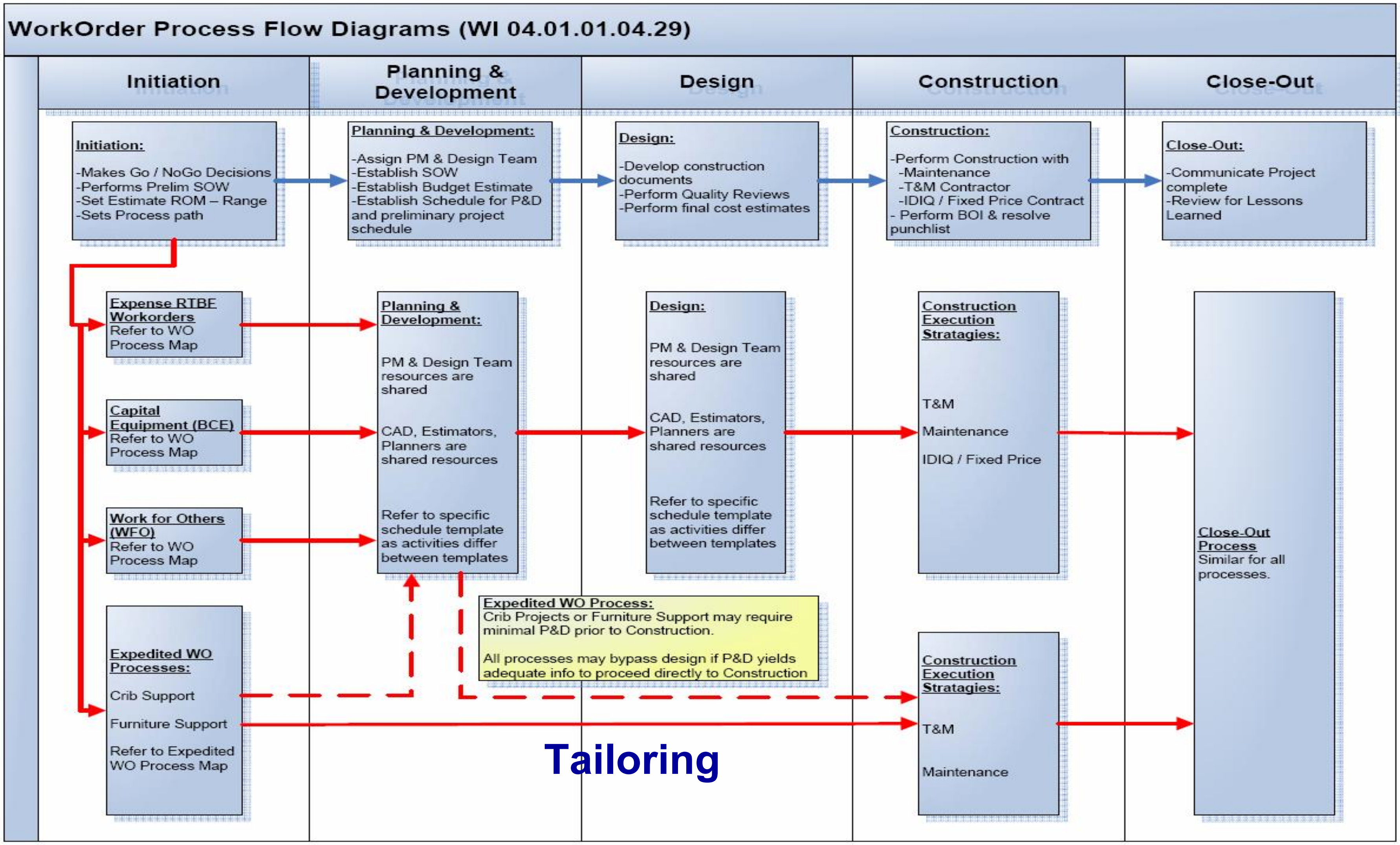

Phase Gates

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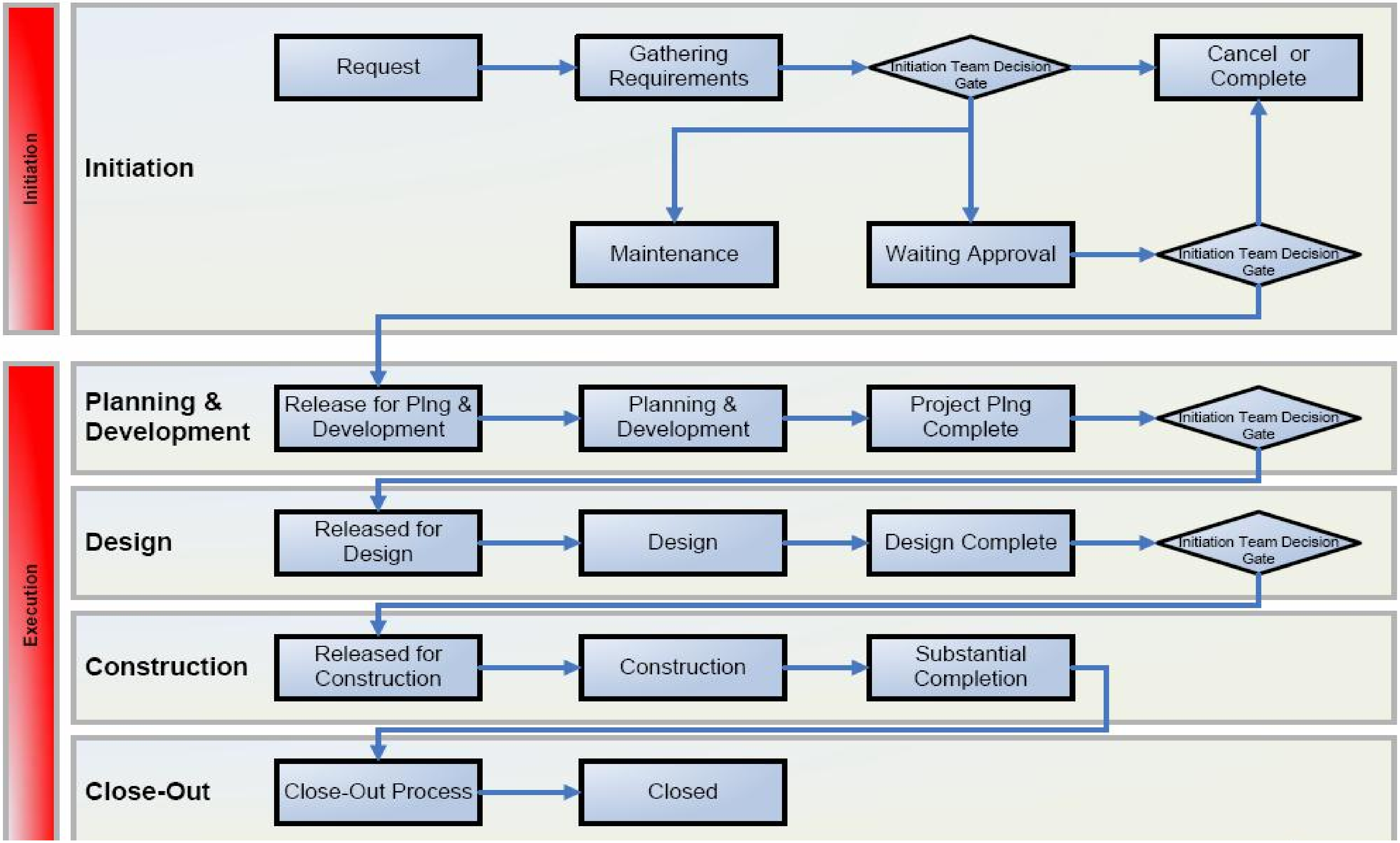

Configuration Management

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Challenge

Mapping Construction Language to CMMI

	Specific Goal and Practices	Typical Work Product	Process/Tool that satisfies SP	Link to Process/Tool
SG 1	**Establish Baselines**			
SP 1.1	**Identify Configuration Items**			
		Scope	How to Control Authorized Projects	04.01.01.04.37
		Schedule		
		Budget		
SP 1.2	**Establish a Configuration Management System**		Need system Description	
		File System	Project Records	04.01.01.04.35
		Command Media	Facilities Reference Manuals	04.01.01.04.21
		Project Database		
		Process Maps		
		QA Manual		
SP 1.3	**Create or Release Baselines**			
		Project Charter	Database	
		SOW	EVMS Work/Budget Authorization	04.01.01.04.37
		Design Criteria	How to Request Project Authorizations	04.01.01.04.08
		Drawings & Specs	Project Layouts	04.01.01.04.22
		PEP	How to Prepare Line Item Documents	04.01.01.04.04
		Authorization Documents	How to Prepare GPP Documents	04.01.01.04.45
SG 2	**Track and Control Changes**			
SP 2.1	**Track Change Requests**			
		emails	How to Perform Project Change Control	01.04.04.00.18
		Q-Reviews	EVMS Change Incorporation	04.01.01.04.37
		Authorization Mods & BCP	How to Control Authorized Projects	04.01.01.04.37
		Project Database		
SP 2.2	**Control Configuration Items**			
		Project Files	How to Close-out Facilities Projects	04.01.01.04.39
			How to Disposition records	01.06.05.00.04
SG 3	**Establish Integrity**			
SP 3.1	**Establish Configuration Management Records**			
		Project Database		
		Change Orders	EVMS Subcontract Management	04.01.01.04.37
		Submittals	Construction Management Manual	
SP 3.2	**Perform Configuration Audits**			
		Audits	Project Records	04.01.01.04.35
		Q-Reviews		
		BOI	How to Disposition records	01.06.05.00.04
		Project Closing Review	How to Close-out Facilities Projects	04.01.01.04.39

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Appraisal Team Members

Internal
External

Jeanie Kitson, President, KAMO Consultancy, LLC (Appraisal Team Lead)

Dave Kitson, Vice President, KAMO Consultancy, LLC

Paul Kimmerly, SEPG Lead, US Marine Corps Technology Services Organization, Kansas City

Valerie Tourangeau, Director of Corp IT Global Quality Programs, Honeywell

Steve Stafford, Construction Oversight Manager, FES, Honeywell Kansas City Plant

Craig Nordeen, Cost Engineer, FES, Honeywell Kansas City Plant

Randy Hamilton, Project Director, FM&T, Honeywell Kansas City Plant

Larry Stotts, Project Engineer, FES, Honeywell Kansas City Plant

Level 2 PA's and RSKM (Continuous)

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Appraisal Interviewees and Document References

- 1 Sponsor
- 5 Project Managers
- 1 Project Director
- 1 Team Manager
- 1 Title III Engineer
- 1 Construction Manager
- 2 Planners
- 2 Cost Engineers
- 1 Architect
- 1 Project Engineer
- 1 Utility Engineer
- 1 Safety Engineer
- 2 Project Control Engineers
- 2 Buyers
- 1 Quality Auditor
- 1 Project Lead

1,985 Document References

- Work and Change Orders
- Electronic Corrective Action Tracking System (eCATS)
- Meeting Minutes
- Risk Analysis Spreadsheets
- Risk Mitigation Plans

$\Big\}$ **Contingency & Management Reserve**

- Maturity Path to Premier Construction Supplier Process
- Beneficial Occupancy Inspectin and Close-Out Processes
- EVMS Data and Quad Reports
- As-built Drawings and Plant Model
- Building Codes, Industry Standards, and Regulations
- Quality Audit Results and Corrective Action Reports

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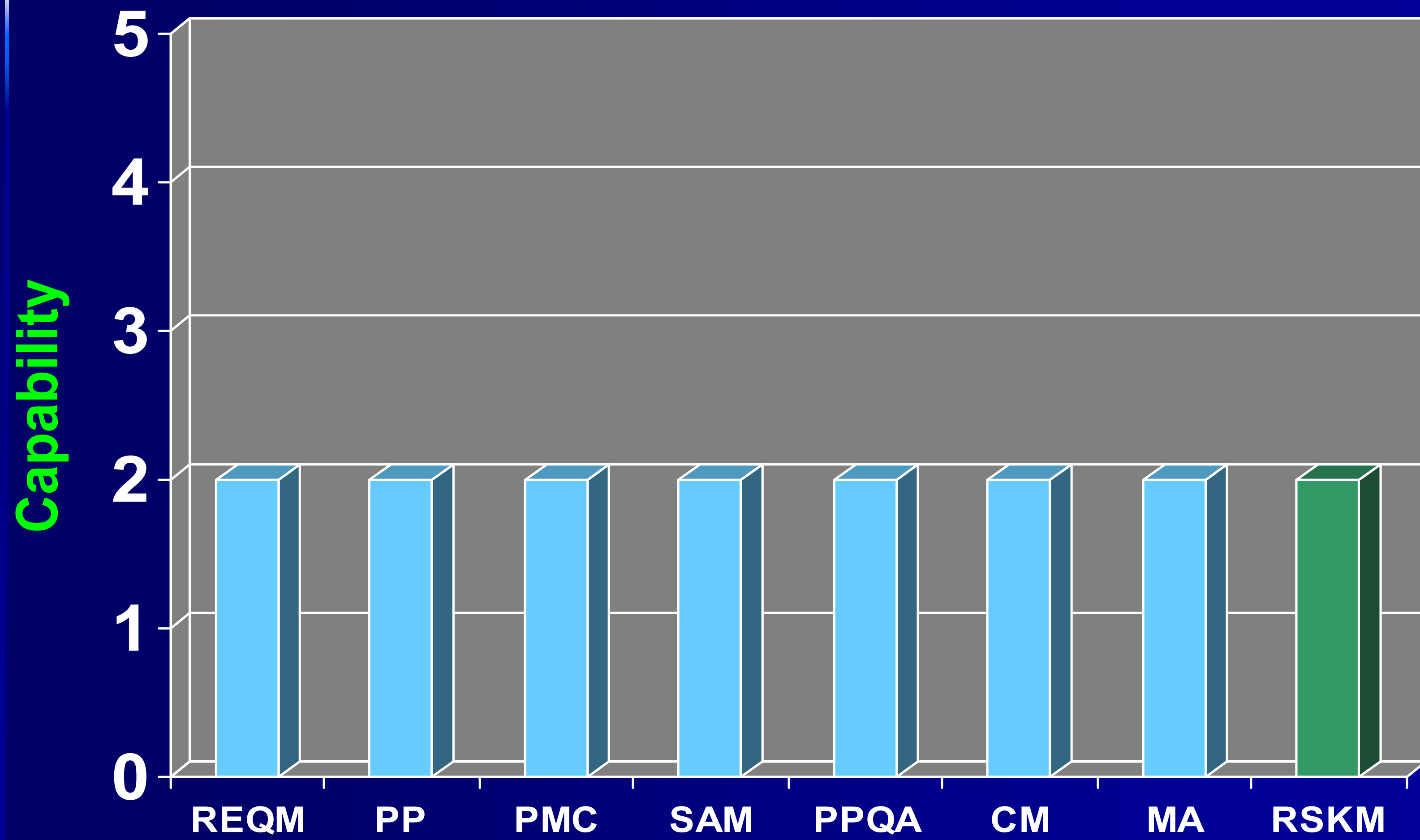
Process Area Profile



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Conclusions

- Understanding the context of Configuration Management and Process and Product Quality Assurance for construction projects required the most appraisal team deliberation.
- The organization is driven to maintain a secure and safe work place for all site personnel. This has created a culture of continually improving work processes.
- CMMI is applicable to facilities maintenance as a service and also to the oldest form of engineering, construction. Many Maturity Level 3 practices were clearly evident in the organization.

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Questions?

Quality Maturity Model

Foundation for process institutionalization

Sanjiv K. Tripathy

Sumit Gupta

RBS - IDC

About Us

Å RBS is the among the top 10 banks in the world, mostly operating in UK, Ireland, US, Others

Å RBS has development centres in Edinburgh, London, India, Others

Å IDC is the largest development centre of RBS outside UK

Å IDC is a 12 year old organization supporting multiple business lines ï Retail & Corporate, Global Banking, Insurance

Å Assessed at CMM level 4, Certified to ISO 9001, 27001. Currently under compliance review of SoX, processes aligned to CMMI level 3

Å Integrated QA team facilitates delivery of implementing Quality strategy

Agenda

Å What is QMM

Å How can QMM help

Å QMM 5 maturity Levels

Å Level 2 - Initial

Å Level 3 - Integrated

Å Level 4 - Quantitatively Managed

Å Level 5 ï Continuous Improvement

Å Summary

What is QMM

Å Model defines strategies and approaches for implementing and institutionalizing Quality assurance strategies in an organization from Initial level to continuous improvement level

Å QMM consists of five maturity levels that reflect a degree of Quality Assurance (QA) process maturity

Å QMM (Quality Maturity Model) is a proven framework, evolved over a period of time while deploying Quality assurance practices in different business lines/programs and identifying practices through

ï pilots

ï learning

ï Implementing best practices

How can QMM Help

Å QMM has been established as a model to support organizations meeting their business objectives

Å QMM can help define a step by step approach on improving and maturing QA practices including quantitative visibility and proactive improvements

Å Higher visibility of project level QA and value addition in overall delivery

Å Easy to use and tailorable framework

Å High level process compliance visible during external assessments/audits

Å Alignment of QA processes for continuous improvements at project level

QMM 5 Maturity Levels

5. Focus on continuous improvement
4. Process measured and controlled
3. QA Process characterized for the **organization** and is aligned to overall SDLC
2. Process characterized for supporting PM processes and is localized
1. QA Process unpredictable, poorly controlled, and reactive

Continuous Improvement

Quantitatively Managed

Integrated

Defined

Initial

Level 1 - Initial

Å Level 1

ï QA processes implemented in ad hoc manner

ï Reactive QA support required due to problems at project level

ï Depends on what project manager want (rather than what is required by the project) and their view of Quality Assurance

ï Individual dependent

ï Even project level processes may not be stable

Level 2 - Defined

- Level 2
  - At this level, projects select QA processes based on their need and implement them.
  - Focus is on having set of QA processes which align well with Project management processes.
  - Some project level QA plan and measurements may be reported
  - Project level facilitation is a focus and reviews may are carried out, if required.
  - Lack of focus of QA approaches across SDLC
  - No consistency across projects/programs and organization wide
  - Lack of integration of project level processes with organization wide existing processes

Level 3 - Integrated

- Level 3
  - At this level, projects implement an organisation wide QA process (which is integrated with other processes as well)
  - They have option to tailor it based on project specific need.
  - At this level, QA processes focus on ensuring across SDLC, processes achieve their goal.
  - QA processes also focus on ensuring organisation wide understanding of processes.
  - Project level reviews are planned along with projects life cycle progress and focus is on both process & product quality reviews.
  - Formal QA metrics defined at organization level are implemented.
  - Process improvements may be initiated based on QA findings/recommendation
  - Organization wide capturing & sharing of Process asset library, learning & suggestions Organization wide Internal quality audit and independent reporting to management
  - Consolidation and reporting of QA results at organization level
  - Organization beginning to focus on implementing best practices from industry specific models

4 ï Quantitatively Managed

Å Level 4

- ï At this level, focus is to manage the QA process quantitatively so that project performance can be provided adequate quantitative visibility including identifying improvements.
- ï Develop Balanced scorecard for organization wide QA processes.
- ï Define control limits to manage QA processes and publish an organization wide process capability baseline
- ï Improvements identified based on analysis of Balanced scorecard & analysis of organization wide QA data
- ï Use of statistical tools for improvements such as 7 QC tools, control charts
- ï Establish Knowledge management framework

5 ï Continuous Improvement

Å Level 5

- ï At this level, focus is to continually improve QA processes to align with ever improving delivery models. Bring in the proactive improvement element.
- ï Identify Continuous improvement activities for QA at organization level & implement them. QA delivers high level of process maturity through industry wide best practice models
- ï Use of formal improvement tools such as six sigma, lean management, Juranôs methodology, workout, for continuous improvement

QMM Process Areas

- Level 2
  - QA Facilitation (Project Level)
  - Process Assurance (PM Activities)
  - QA Measurements (Project Level)
- Level 3
  - Software Quality Assurance (SQA)
  - Internal Quality Audit (IQA)
  - QA Process Definition & tailoring of processes
  - QA metrics definition and reporting
  - Process improvements
- Level 4
  - Quantitative Management of QA processes
  - Knowledge Management (KM)
- Level 5
  - Causal Analysis and Resolution
  - Continuous Improvement

L2 ï QA Facilitation

Å <u>QA facilitation at project level</u>

Identify and perform facilitation

SQA facilitation is performed for supporting day to day process need for projects

1. Manage queries on processes by projects
2. Guide project manager in tailoring processes and templates
3. Conduct training on project specific QA processes
4. Support improvements at project level
5. Assist project for any external certification and assessments

cess Assurance (PM activities)

Å <u>Perform Process Assurance focusing on (PM activities)</u>

Identify and perform process assurance for project management related activities

1. Review project plan and project schedule for the project at defined frequency
2. Establish risk management in the project
3. Support project level tracking & reporting
4. Take corrective action on review findings as and when required

Measurements (Project level)

Å Project level QA measurements reporting (schedule, effort)

Identify and report QA measurements at the project level

1. Define measurement to measure QA performance for individual projects
2. Report status at project level

ware Quality Assurance (SQA)

Following are the high level practices for the process area:

- **SQA Planning**
  - Plan for SQA activities
  - Plan for SQA Resourcing
- **SQA Activities**
  - SQA Process Review
  - SQA Product Review
- **SQA Monitoring and Control**
  - Monitor SQA Plan
  - Conduct Progress Review

re Quality Assurance (SQA) (contdé)

Å [Plan for SQA activities]

Plan for management of project SQA activities

SQA prepares a periodic schedule of the planned SQA activities .The schedule covers the following tasks:

» Process reviews

» SQA facilitation

» Document reviews

1. Identify all SQA activities for the period with planned effort
2. Establish a mechanism to take input and agreement from project manager for SQA plan. Align with project plan
3. Update plan on a defined frequency

re Quality Assurance (SQA) (contdé)

- Plan for SQA Resourcing

Establish and maintain the SQA resource

Better planning and identification of SQA resources in advance help in supporting the projects better and avoid and surprises.

1. Establish and maintain an organizational policy for planning and performing the SQA process
2. Provide adequate resources for performing the SQA process
3. Assign responsibility and authority for performing the SQA process
4. Train the people performing or supporting the SQA process as needed
5. Collect historical data on SQA effort and the activities performed
   - This data act as a basis for identifying the average SQA effort which is required for forecasting the SQA resources.

re Quality Assurance (SQA) (contdé)

Å SQA Process Review

Objectively evaluate the designated performed SDLC processes against the applicable process descriptions, standards, and procedures.

1. Establish and maintain clearly stated criteria for the evaluations.
   - Å What will be evaluated
   - Å When or how often a process will be evaluated
   - Å How the evaluation will be conducted
   - Å Who must be involved in the evaluation
2. Use the stated criteria to evaluate performed processes for adherence to process descriptions, standards, and procedures.
3. Identify each noncompliance found during the evaluation.
4. Identify lessons learned that could improve processes for future products and services.

re Quality Assurance (SQA) (contdé)

Å SQA Product Review

Objectively evaluate the designated work products and services against the applicable process descriptions, standards, and procedures.

1. Select work products to be evaluated, based on documented sampling criteria if sampling is used.
2. Establish and maintain clearly stated criteria for the evaluation of work products.
3. Use the stated criteria during the evaluations of work products.
4. Evaluate work products before they are delivered to the customer.
5. Evaluate work products at selected milestones in their development.
6. Perform in-progress or incremental evaluations of work products and services against process descriptions, standards, and procedures.
7. Identify each case of noncompliance found during the evaluations.

re Quality Assurance (SQA) (contdé)

Å Monitor SQA Plan

Monitor commitments against those identified in the SQA plan.

1. Regularly review commitments (both external and internal).
2. Identify commitments that have not been satisfied or that are at significant risk of not being satisfied.
3. Document the results of the commitment reviews.

re Quality Assurance (SQA) (contdé)

Å Conduct Progress Review

Periodically review the QAG progress, performance, and issues.

1. Review of QA group progress on the plan at defined frequency (weekly, monthly) to track performance of plans, issues/ findings raised during reviews and their status/ escalations.
2. Share summary status with stakeholder management

Typical Work Products

ï QAG task list

ï Project Status Review

ï QA group metrics

Internal Quality Audit (IQA)

Following are the high level practices for the process area:

- **Planning IQA**
- **Conducting IQA**
- **Monitoring & closing IQA**

ernal Quality Audit (IQA) (contdé)

Å Planning IQA

Establish a high-level yearly IQA plan.

1. Identify the various sources of input to the plan. The various sources can be:
   - Å Inputs from Senior Management
   - Å Inputs from project/program milestones
   - Å Input from previous yearõs Internal Quality Audit reports/external audit/ assessment plans
   - Å Inputs from SQA Plan
2. Develop the plan at the start of the year
3. Review and update the plan

ernal Quality Audit (IQA) (contdé)

- Planning IQA (contd..)

Establish and maintain monthly IQA schedule as per the defined audit coverage criteria

1. Develop and define the audit coverage criteria.

   The coverage for the projects can be based on various factors like size, complexity, iSQA findings. Support groups can also be identified to be covered at a specified frequency (typically once in quarter)

2. Develop monthly IQA schedule and circulate it to all key stakeholders (auditor and auditee) for their acceptance
3. Make available the plan at a central repository for all stakeholders

ernal Quality Audit (IQA) (contdé)

Å Conducting IQA

Perform audit as per the schedule.

1. The Internal Audit is conducted as per the published processes used for carrying out the activities.
2. Project Manager is responsible to show the evidences of process documentation.
3. Internal auditor(s) will record the findings in audit note sheet and get it signed off from auditee.
4. Based on the findings, the auditor will prepare the internal audit report
5. The approved internal audit report is sent to Project Manager for filling the corrective and preventive actions.

Typical Work Products

1. IQA report

ernal Quality Audit (IQA) (contdé)

Å Monitoring & Closing IQA

Monitor the IQA progress against the planned schedule and follow up for closure of non-conformances.

1. Monitor IQA progress against the schedule.
   - Å Progress monitoring typically includes the following:
     - Å Periodically measuring the actual completion of activities and milestones
     - Å Identifying significant deviations from the schedule estimates in the IQA plan
2. Document the significant deviations in the project planning parameters.
3. Follow up on closure of identified non-conformances and observations
4. Perform escalation in a timely manner to avoid process breakthrough situation

ï QA Process Definition

Following are the high level practices for the process area:

Å **Establish Quality Group Process Assets**

Å **Establish Tailoring Criteria and Guidelines**

Å **Establish the Quality Group's Process Asset Library**

QA Process Definition (contdé)

Å <u>Establish Quality Group Process Assets</u>

Establish quality group process assets.

1. Decompose each standard process into constituent process elements to the detail needed to understand and describe the process.
2. Specify the critical attributes of each process element.
3. Ensure that there is appropriate integration among the processes that are included in the organizationÕs set of standard processes.
4. Document the organization's set of standard processes.
5. Conduct peer reviews on the organization's set of standard processes.
6. Revise the organization's set of standard processes as necessary.

QA Process Definition (contdé)

Å <u>Establish Tailoring Criteria and Guidelines</u>

Establish and maintain the tailoring criteria and guidelines for the quality group's set of standard processes.

The tailoring criteria and guidelines describe the following:

1. Mandatory requirements that must be satisfied by the defined processes
2. Options that can be exercised and criteria for selecting among the options
3. Procedures that must be followed in performing and documenting process tailoring

Typical Work Products

1. Tailoring guidelines

QA Process Definition (contdé)

Å <u>Establish Quality Group Process Asset Library</u>

Establish and maintain the process asset library.

1. Design and implement the quality groupôs process asset library, including the library structure and support environment.
2. Specify the criteria for including items in the library.
3. Specify the procedures for storing and retrieving items.
4. Enter the selected items into the library and catalog them for easy reference and retrieval.
5. Make the items available for use by the projects.
6. Periodically review the use of each item and use the results to maintain the library contents

L3 ï Metrics Reporting

Following are the high level practices for the process area:

Å **Establish a metrics framework**

Å **Report metrics**

Metrics Reporting (contdé)

Å Establish a metrics framework

Establish a mechanism for metrics definition for QA group.

1. Define the various measures required for QA group
2. Identify the data collection mechanism and consolidation
3. Identify the tailorable aspects of metrics if any
4. Integrate the metrics as part of overall QA processes
5. Tolerance for metrics to be defined and used for tracking and reporting

Metrics Reporting (contdé)

Å Report metrics

Establish a mechanism for metrics reporting at QA group level and organization level.

1. Consolidation of data in a central repository
2. Report the metrics at identified frequency
3. Reporting of metrics data through QA group reports and organization wide reports

. ï Process Improvement

Å <u>Perform process improvement</u>

Establish a mechanism for performing process improvement arising out of project recommendations/QA findings.

1. Define the mechanism of receiving/identifying QA findings / recommendations / suggestions
2. Perform impact analysis and identify the necessary process changes
3. Make changes to the process and sent it for review
4. Approved improvement is incorporated into organization wide QA processes

Quantitative Management

Following are the high level practices for the process area:

- **Establish measurement objectives**
- **Specify Measures**
- **Specify Data collection and Storage procedures**
- **Specify Analysis procedures**
- **Identify improvements**

Quantitative Management

- Establish measurement objectives

Measurement objectives documents the purpose for which measurement and analysis are done, and specify the kind of actions that may be taken based on the results of data analyses.

1. Set up QA group measurement objectives aligned to measure performance against 4 quadrants of Balanced Scorecard
2. The sources for measurement objectives may be management, technical, project, product, or process implementation needs.
3. Example of measurement objectives include the following:
   - Findings/Non-conformances closure cycle time
   - Cycle time/Benefits of implementation of learning/suggestion/best practices

antitative Management (contdé)

Å Specify Measures

Measurement objectives driven from BSC are refined into precise, quantifiable measures.

1. Identify measures for each of the 4 quadrants (Delivery, People, Financial, Customer)
2. Measures may be either ñbaseò or ñderived.ò Data for base measures are obtained by direct measurement. Data for derived measures come from other data, typically by combining two or more base measures.
3. Establish goal and thresholds for the defined BSC measures
   - ï Goals and thresholds may be either developed using analysis of historical data (through PCB) or through management targets / priorities
4. Examples of commonly used base measures include the following:
   - Å *Average non-conformance closure cycle time*
   - Å *IQA compliance with monthly schedule*
   - Å *Overall staff retention*
5. Examples of commonly used derived measures include the following:
   - Å *No. of SQA findings per project per review*
   - Å *Average SQA effort /project/month*
   - Å *No. of training hours per year per member*

antitative Management (contdé)

Å Specify data collection and storage procedures

Explicit specification of collection methods helps ensure that the right data are collected properly. It may also aid in further clarifying information needs and measurement objectives.

1. Identify existing sources of data that are generated from current work products, processes, or transactions.
2. Identify measures for which data are needed, but are not currently available.
3. Specify how to collect and store the data for each required measure.

antitative Management (contdé)

Å Specify Analysis procedures

Specifying the analysis procedures in advance ensures that appropriate analyses will be conducted and reported to address the documented measurement objectives (and thereby the information needs and objectives on which they are based). This approach also provides a check that the necessary data will in fact be collected.

1. Following are the analysis mechanisms used:
   Å Process Capability Baseline

antitative Management (contdé)

Å Process Capability Baseline

1. PCB represents performance of various QA group processes in the organization in quantitative terms. It also forms as a basis for predicting the behavior of the processes in near future assuming that similar kind of work will be performed.
2. Measurements and metrics related to QA group which have to be baselined are identified and prioritized.
3. Prepare an analysis report using appropriate statistical techniques
4. Use analysis of data to set / refine goal and thresholds for measures in BSC
5. Example of high level metrics which can be baseline are:
   - Å Average SQA effort/project/month: It helps in forecasting the actual QA resource requirement for the future projects.
   - Å Number of SQA findings/project/review: It helps in identifying the process compliance in the projects.

antitative Management (contdé)

Å Identify improvements

Improvements are formally identified from the data analysis performed.

1. Improvements are identified from Balanced scorecard, PCB using statistical tools like 7 QC tools.
2. Analyze the organization's set of standard processes to determine areas where improvements would be most helpful
3. Pilot improvements
4. Select improvements for deployment

Knowledge Management

Å Establish Knowledge Management

Set up knowledge management framework

1. Identify an appropriate tool to deploy the KM framework
   ï Example of tools can be workflow systems (Lotus Notes), Internet based applications, excel based tool.
2. Set up KM framework to capture knowledge at various part of SDLC (e.g. Best practices, learning)
3. Organize the received assets
4. Share the knowledge through documents
5. Use/reuse the assets
6. Identify improvements if any

owledge Management (contd..)

Find / Create

- Project/Functional group Experiences
- Queries/Solutions
- Tips &Tricks
- Best Practices (Industry)
- Post Project Review

Organize

- Categorization
- Review & approve

Share

- Document
- Distribute

Use / Reuse

- Search for examples, query resolutions
- Discussion forum/Practice Communities
- Usage of available assets.
- Knowledge Sharing

Improvement

- Rating & evaluation
- Assets improvement.
- Benefits realized
- Lessons learnt
- KM Process/Tool Improvement

ausal Analysis & Resolution

Following are the high level practices for the process area:

Å **Determine Causes of Non-conformances**

Å **Analyze Causes**

Å **Implement the Action Proposals**

sal Analysis & Resolution (contdé)

Å <u>Determine Causes of Non-conformance</u>

Root causes of non-conformances and other findings are systematically determined..

1. Gather relevant non-conformance and finding data.

   Examples of relevant non-conformance data may include the following:

   ï Internal quality audit non-conformances

   ï QA review findings

2. Determine which non-conformances and other findings will be analyzed further.

   Examples of methods for selecting defects and other problems include the following:

   Å Pareto analysis

   Å Histograms

   Å Control Charts

sal Analysis & Resolution (contdé)

Å Analyze Causes

Root causes of non-conformances and other findings are systematically determined..

1. Conduct causal analysis with the people who are responsible for performing the task.
2. Analyze selected non-conformances and other findings to determine their root causes.
3. Propose and document actions that need to be taken to prevent the future occurrence of similar non-conformances and other findings.

sal Analysis & Resolution (contdé)

Å Implement the action proposals

Implement the selected action proposals that were developed in causal analysis.

1. Analyze the action proposals and determine their priorities
2. Select the action proposals that will be implemented.
3. Create action items for implementing the action proposals

Continuous Improvement

Å <u>Continuously improve the processes</u>

Identify and continuously deploy the new improved processes / tools / methods

1. Identify CI initiatives to achieve organization objectives/goals identified in Balanced Scorecard
2. Take up CI projects using appropriate tools such as six sigma, lean management, work out
3. Encourage cross functional team based CI
4. Review performance of initiatives / CI projects
5. Report status & benefits to management

Summary

	QA Process Maturity	Project / Program Process Maturity
Level 2	Å QA focused on facilitating project management processes ÅQA review PM artifacts ÅQA reporting at project level	ÅMatured PM processes for projects ÅBetter quality PM deliverables ÅBetter insight into regular project monitoring & tracking
Level 3	ÅQA process focused on establishing process asset library, initial metrics framework ÅIQA is established ÅSQA support for entire SDLC	ÅSharing of learning / best practices across projects ÅSQA support for entire SDLC leading to improve engineering deliverables ÅThird party view of project through IQA ÅPro-active identification of findings
Level 4	ÅKnowledge Management ÅQuantitative Management	ÅQuantitative visibility into QA process management through BSC ÅEnd to end active repository for project learning, documents, tips & tricks.
Level 5	ÅCausal Analysis & Resolution ÅContinuous improvement	ÅDecrease in in process and post delivery defects using identified CI tools ÅImproved budget using innovative techniques for executing projects

Thank you

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CMMI for Services:

Re-introducing the CMMI for Services Constellation

CMMI Technology Conference and User Group
November 12-15, 2007

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Drew Allison
Systems and Software Consortium Inc.

Frank Niessink
DNV-CIBIT

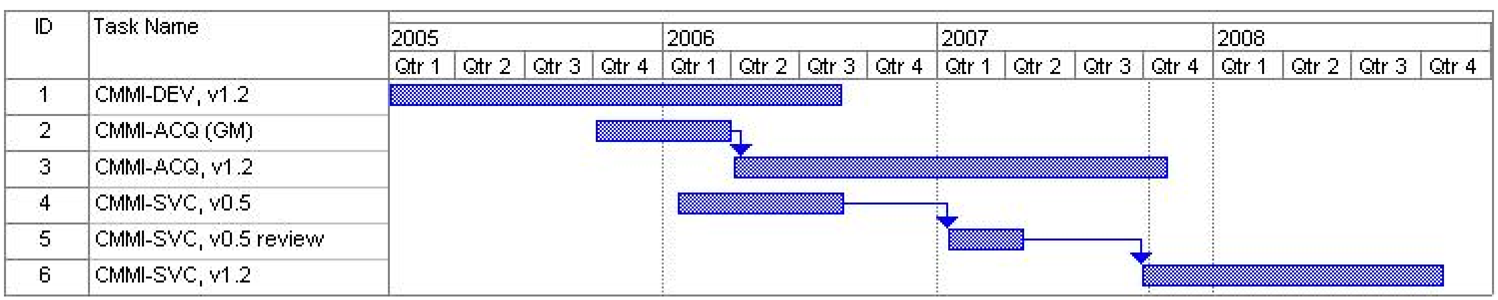
CMMI®

Agenda

- CMMI-SVC News
- Overview of the draft CMMI for Services (CMMI-SVC)
  - What is the CMMI?
  - Why is the CMMI-SVC needed?
  - How are services different?
  - What is the basis for the CMMI-SVC model?
  - What is the scope and content of the CMMI-SVC?
- Feedback to date
  - What was the result of the expert review?
  - What was the experience of the pilot projects?
- Next Steps
  - What is the schedule?
  - How can I participate?

ering Group OK's CMMI for Services

- There was a serious concern that concurrent development of the CMMI-ACQ and CMMI-SVC models would stress the SEI resources needed to deliver the CMMI-ACQ model on time. Now that CMMI-ACQ is almost released, the SEI resources are available to go forward with the CMMI-SVC development.

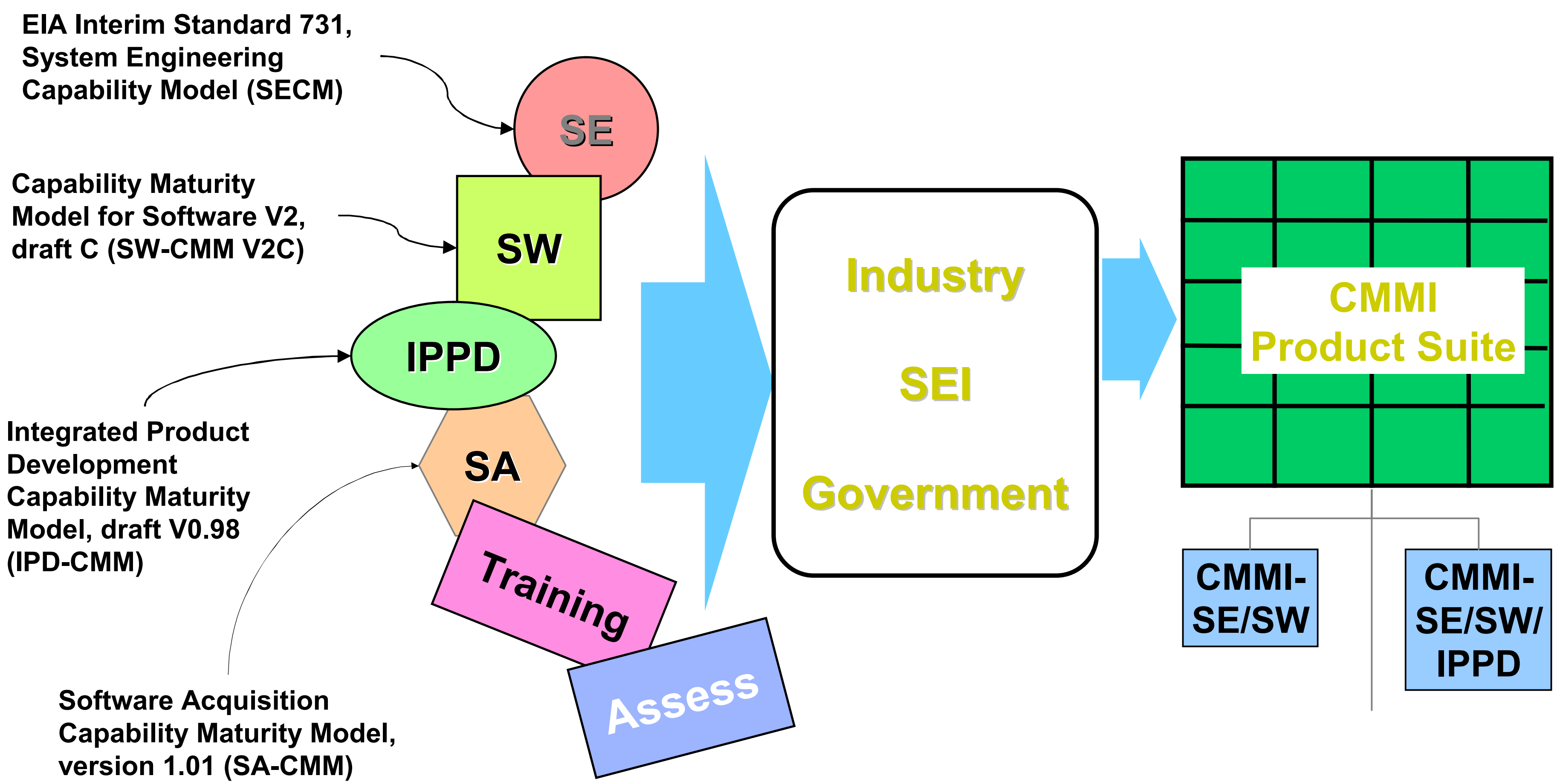


Capability Maturity Model (CMM)?

- A conceptual framework for structuring, understanding, and evaluating the capability and maturity of an organization's processes
  - more than a laundry list of best practices
  - more than a collection of benchmarks and metrics
- A tool that enables meaningful, in-depth organizational assessment
  - internally
  - externally
- A map that guides practical process improvement and institutionalizes it
  - How to you get from *here* to *there* and *stay there*?

What is the CMMI?

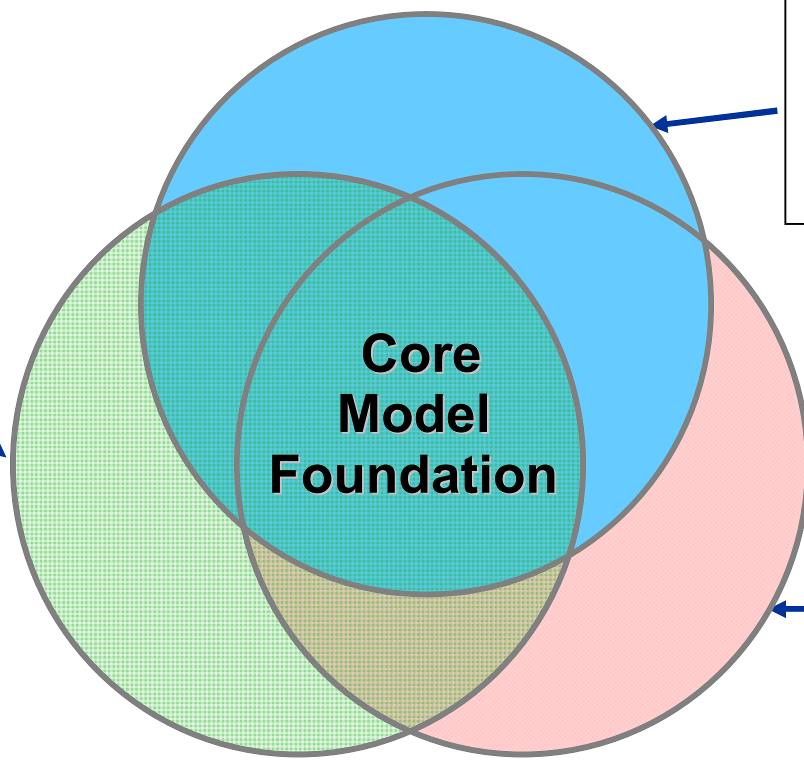
- The CMM Integration[SM] (CMMI) of multiple CMMs into a single unified framework



plementary constellations

CMMI-DEV
provides guidance for measuring, monitoring, and managing development processes

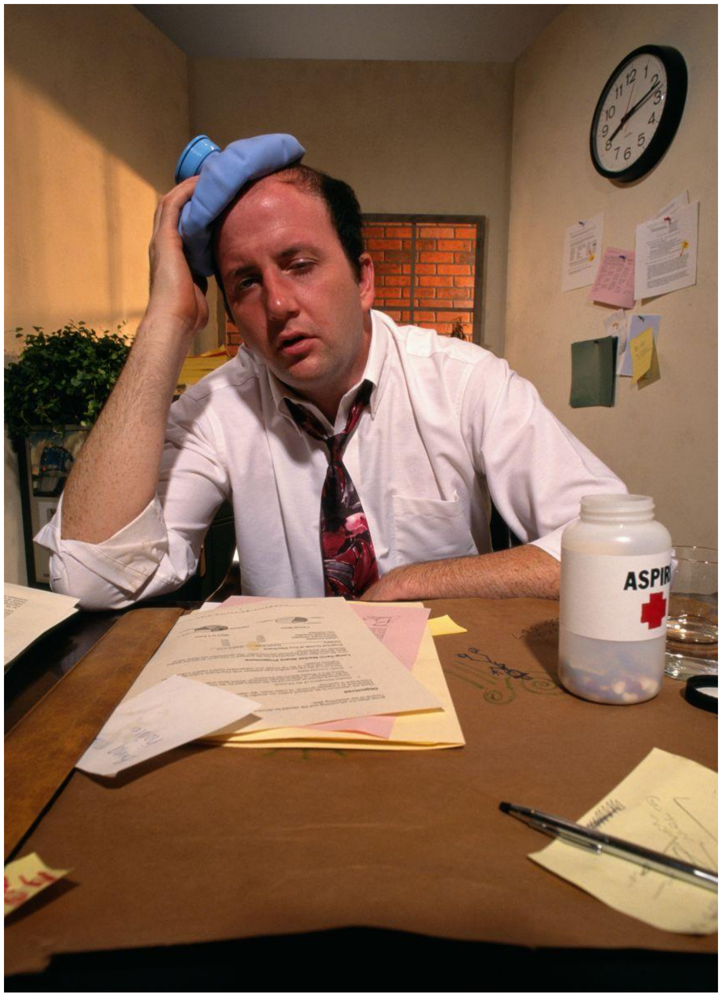
CMMI-SVC
provides guidance for those providing services within organizations and to external customers



CMMI-ACQ
provides guidance to enable informed and decisive acquisition leadership

Courtesy of the SEI

…MMI for Services (CMMI-SVC) needed?



- Customer discontent
- Service society
- Legislation
- Government and industry trends

How are services different?

- Services form a distinctive category of products
  - A service is an intangible, non-storable product
  - What makes a service intangible or non-storable?
    - Customer desires a situation or state (e.g., to have high network availability) rather than a tangible artifact
    - Provider delivers value without independent, unrestricted means of generating/employing that value by the customer (e.g., leasing vehicles)
    - Product delivery requires continuing application of labor (e.g., operation of a facility)
- Services imply customer/provider relationships governed by service agreements
  - Service and non-service products may be delivered as part of a single agreement (e.g., training that includes hardcopy materials)
- Services are often delivered via the operation of a service system

Service system

- A necessary concept for understanding the effective delivery of services
- An integrated and interdependent combination of processes, resources, and people that satisfies service requirements.
- Portions are not delivered to the customer or end-user as part of service delivery
- Portions may remain owned by the customer or end-user before service delivery begins and after service delivery ends.
- Encompasses everything required for service delivery, including work products, processes, infrastructure, consumables, and customer resources.

e scope of CMMI-SVC?

CMMI®

- Covers practices required to manage, establish, and deliver services, in four process area categories
  - Project (service) management
  - Process management
  - Service support
  - Service establishment and delivery
- Intended to match the scope of the definition of services
- Broad applicability to a range of service domains
  - Information technology, engineering, defense, transportation, finance, health care
- Staff augmentation services need careful consideration
  - How do you evaluate process improvement for processes over which you have no control?

CMMI-SVC Process Areas

- **Process Management**
- Organizational Innovation and Deployment (OID)
- Organizational Process Definition (OPD)
- Organizational Process Focus (OPF)
- Organizational Process Performance (OPP)
- *Organizational Service Management* (OSM)
- Organizational Training (OT)

- **Service Support**
- Causal Analysis and Resolution (CAR)
- Configuration Management (CM)
- Decision Analysis and Resolution (DAR)
- Measurement and Analysis (MA)
- *Problem Management* (PRM)
- Process and Product Quality Assurance (PPQA)

Service Establishment and Delivery

- *Incident and Request Management* (IRM)
- *Service Delivery* (SD)
- *Service System Development* (SSD)
- *Service Transition* (ST)

Project Management

- *Capacity and Availability Management* (CAM)
- Integrated Project Management (IPM)
- Project Monitoring and Control (PMC)
- Project Planning (PP)
- Requirements Management (REQM)
- Risk Management (RSKM)
- Quantitative Project Management (QPM)
- *Service Continuity* (SCON)
- Supplier Agreement Management (SAM)

Services-specific PAs

Process Area	Maturity Level	Specific Goals/ Practices
Capability and Availability Management (CAM)	3	2 / 6
Incident and Request Management (IRM)	2	2 / 6
*Organizational Service Management (OSM)**	3	2 / 7
Problem Management (PRM)	3	2 / 7
*Service Continuity (SCON)**	3	3 / 10
Service Delivery (SD)	3	2 / 7
*Service System Development (SSD) **	3	3 / 12
Service Transition (ST)	3	3 / 12

* optional process areas (independent named additions)

CMMI-SVC Level 2 PAs

- Incident and Request Management
  - To ensure the timely resolution of requests for service and incidents that occur during service delivery
- Requirements Management
  - Extended from the Core Model Foundation with an additional goal
  - To include the establishment and maintenance of written agreements between service providers and customers on service requirements and service levels.
- Six other level 2 PAs from the CMF

CMMI-SVC Level 3 PAs

- Capacity and Availability Management
  - To plan and monitor the effective provision of resources to support service requirements
- Problem Management
  - To prevent incidents from recurring by identifying and addressing underlying causes of incidents
- Service Delivery
  - To deliver services in accordance with service agreements
- Service Transition
  - To deploy new or significantly changed service systems while managing their effect on ongoing service delivery

As for CMMI-SVC Level 3

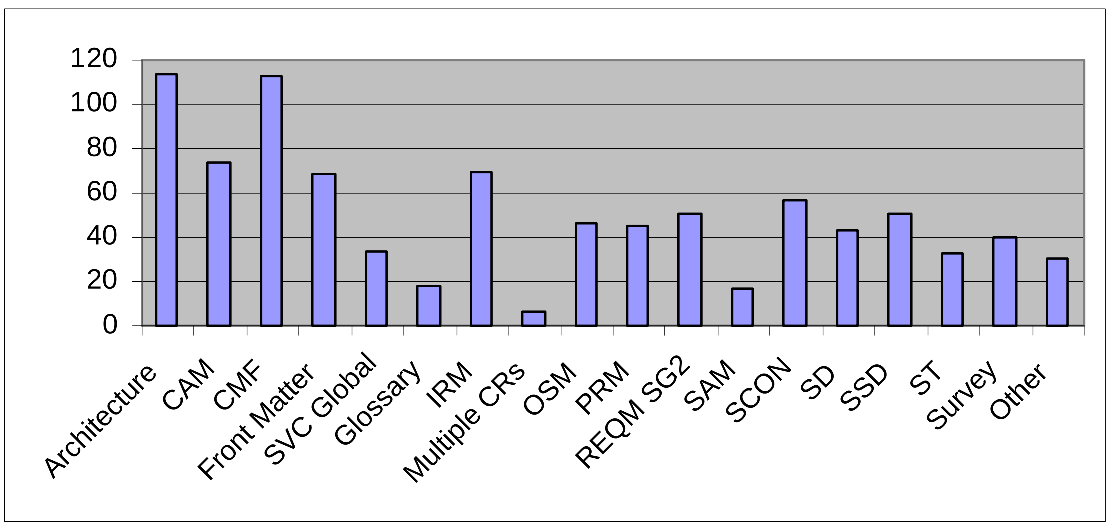
- Organizational Service Management
  - To establish and maintain standard services that ensure the satisfaction of the organization's customer base
- Service Continuity Management
  - To establish and maintain contingency plans for continuity of agreed services during and following any significant disruption of normal operations
- Service System Development
  - To analyze, design, develop, integrate, and test service systems to satisfy existing or anticipated service agreements

the result of the expert review?

- An expert review was held Jan 23 - Mar 23, 2007
  - 500+ reviewers, representing:
    - 50 companies,
    - 14 DoD organizations,
    - 4 academic institutions, and
    - 7 professional, governmental, or research centers
    - Reviewers included SEI transition partners
- Response showed strong interest in CMMI-SVC
  - 900+ change requests compares favorably to those received for CMMI-DEV
  - 50 survey responses to architectural questions

the result of the expert review? (more)

- Reviews commented most on CMM-SVC architecture & Common Model Foundation material
- CRs were distributed equally among categories related to SVC PAs
- CMMI-SVC team has analyzed all architectural CRs; most have a proposed resolution
- CRs showed excellent depth of insight and rich informative content



Sample Survey Responses

- The service practices that are covered in CMMI-SVC will enable service organizations to provide more effective support to their customers.

Strongly Agree or Agree	Neutral	Disagree or Strongly Disagree
78.9%	8.8%	12.3%

- The material in CMMI-SVC yields a useful adaptation of CMMI best practices as they relate to service deployment.

Strongly Agree or Agree	Neutral	Disagree or Strongly Disagree
66.7%	14.0%	15.8%

- CMMI-SVC does not impose constraints (derived from the needs of a specific service or market segment) that would limit or prevent other organizations from adapting the model to their own specific needs.

Strongly Agree or Agree	Neutral	Disagree or Strongly Disagree
55.6%	29.6%	27.8%

- The CMMI-SVC is easy to understand and apply to a service organization.

Strongly Agree or Agree	Neutral	Disagree or Strongly Disagree
42.8%	27.8%	29.6%

… the experience of the pilot projects?

- Planned pilots were postponed
- CMMI-SVC participating companies piloted the model internally
- Characteristics of the piloted organizations:
  - Most had implemented CMMI-DEV
  - Some had separate ITIL and ISO 20000 initiatives
  - Most are moving towards integration under CMMI umbrella
- The pilots represented the following service domains:

Company	Service Domains
SSCI	IT Application Operations & Support
DNV-CIBIT	Banking
Northrop Grumman	Logistics, HR, IT, Applications O&M

he pilots see as benefits ?

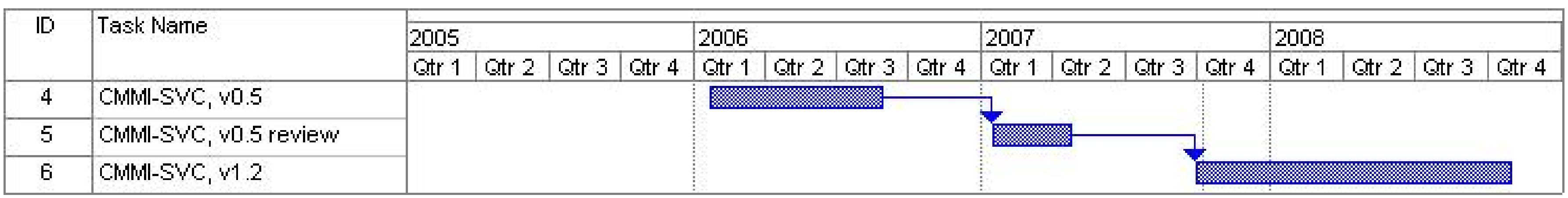
- Improved quality of services
- Encouraged a disciplined culture for service management
  - Better management visibility into services
  - Fewer surprises
  - Fosters process improvement
- Less Interpretation issues (& appraisal expense) than with CMMI-DEV
- Applying a CMMI process to the services brought credibility and buy-in from stakeholders
- Increased sharing between development and services communities
  - Common processes
  - Standard terminology
  - Integrated process improvement standards and models
- Encouraged end-to-end lifecycle process approach helping to identify service requirements, ease deployment issues, reduce stove-piped groups, and improve efficiencies of support-related groups (IT Applications)

…he pilots see as challenges?

- Obtaining funding in environments that are primarily LOE-based
- Differences in terminology between development and services
  - Terms like ñProjectò (funding period), ñProductò (service), ñWork Productò, ñProduct Componentò, ñRequirementò
  - Interpreting CMMIôs ñprojectò term for services
- No standard life-cycle definition for services
- Instilling project management culture in services
  - Weak in using requirements for planning and negotiating resources and activities
- Ownership of service system components not as clear
- Release management and deployment to non-standardized, constantly changing environments
- Finding CMMI-knowledgeable individuals who also know services
- Integrating process groups and assets
- Services where customer and provider share resources and processes
- Staff augmentation

What is the schedule?

- CMMI-SVC team will meet to review additional requirements and re-plan remaining work (early Nov)
- Detailed schedule is pending
- A preliminary estimate for release of CMMI-SVC, v1.2 is 4th quarter 2008



How can I participate?

- Get more information about CMMI-SVC
  - CMMI web page - http://www.sei.cmu.edu/cmmi/
  - CMMI for Services Public Workspace (http://bscw.sei.cmu.edu/bscw/bscw.cgi/0/424939) contains:
    - Draft CMMI-SVC model, v0.5
    - Information on joining CMMI-SVC information email list
- Review draft CMMI-SVC release
- If already experienced in CMMI, consider piloting the model
- Other opportunities may exist as a result of the CMMI-SVC re-planning effort; watch CMMI-SVC public workspace for updates

Backup

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...rking on CMMI-SVC?

- Development Team
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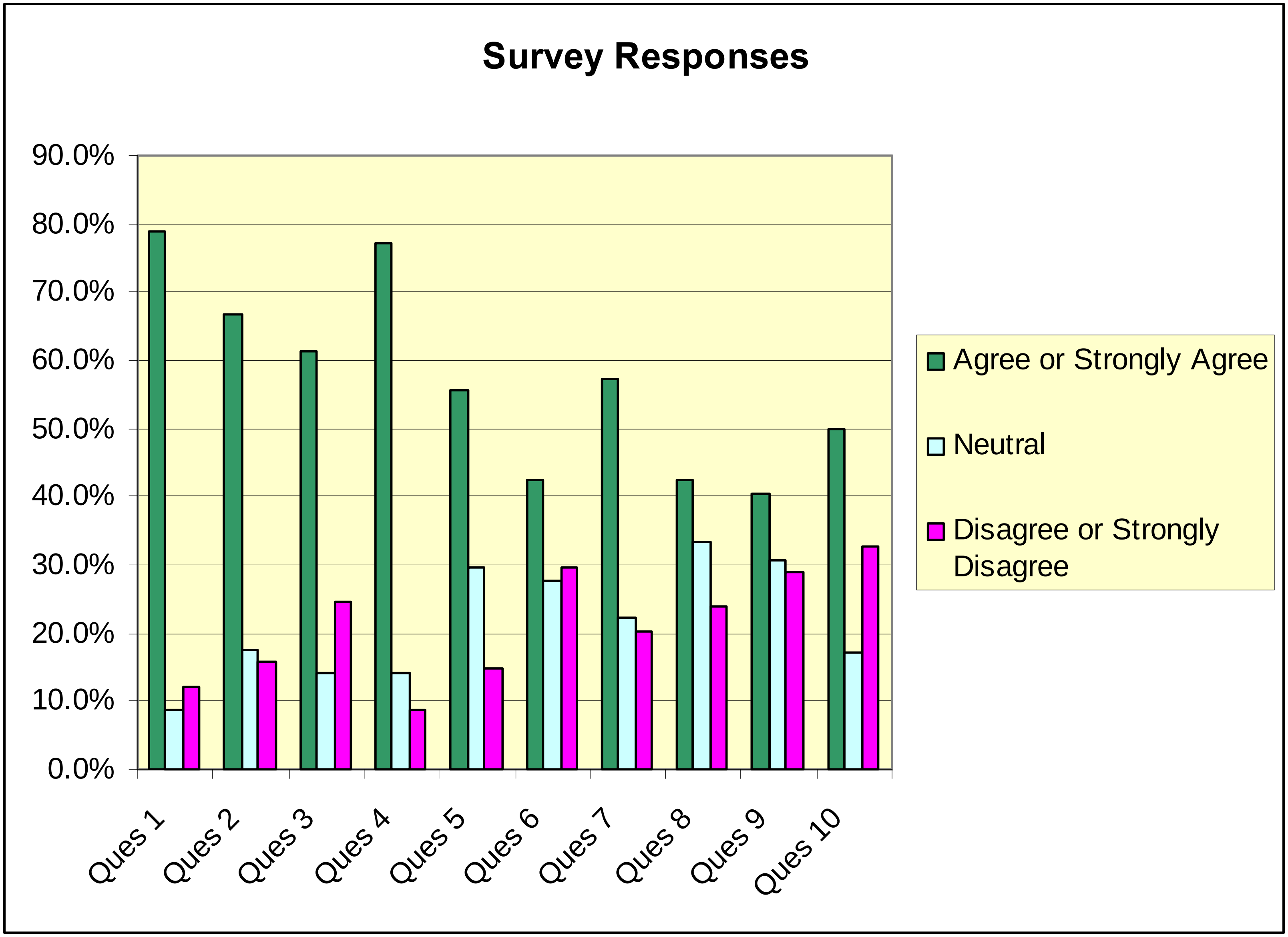
  - Roy Porter (Northrop Grumman)
  - Brandon Buteau (Northrop Grumman)
  - Lynn Penn (Lockheed Martin)
  - Frank Niessink (DNV/CIBIT)
  - Jerry Simpson (SAIC)
  - Drew Allison (SSCI)
  - Eileen Forrester (SEI)
  - Barbara Tyson (SEI)
  - Eileen Clark (SRA)
- Other contributors
  - Jeff Zeidler (Boeing)
  - Rich Raphael (Mitre)
  - Joanne OõLeary (SEI)

General Survey Questions

1. The service practices that are covered in CMMI-SVC will enable service organizations to provide more effective support to their customers.
2. The material in CMMI-SVC yields a useful adaptation of CMMI best practices as they relate to service deployment.
3. The CMMI-SVC appropriately uses the CMMI framework.
4. CMMI-SVC includes process areas that must be satisfied for process improvement and institutionalization.
5. CMMI-SVC does not impose constraints (derived from the needs of a specific service or market segment) that would limit or prevent other organizations from adapting the model to their own specific needs.
6. The CMMI-SVC is easy to understand and apply to a service organization.
7. The process areas in CMMI-SVC cover all significant service-specific requirements and effectively reflect activities that a service organization should be accomplishing.
8. Additions and amplifications that exist in other models and are also used within the CMMI-SVC constellation are appropriate.
9. Notes and examples in CMMI-SVC clearly apply to service organizations and meet their specific needs.
10. References in PAs to related process areas are clear and consistently applied.

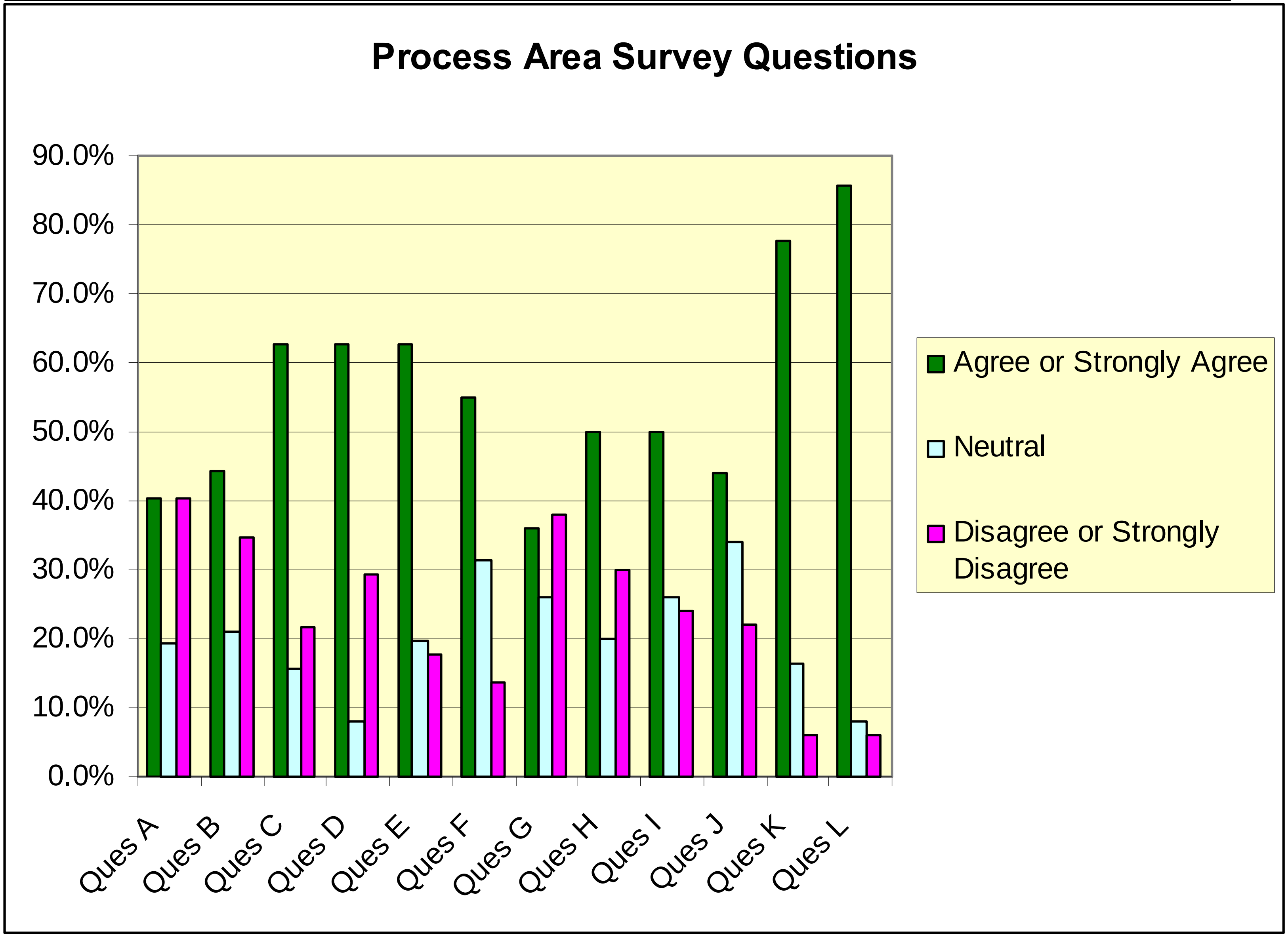
Results to General Survey



Process Area Questions

A. Problem management practices that are common within the service industry are appropriately addressed in the process area Problem Management and are distinguished from the practices in the Causal Analysis and Resolution process area.
B. The Project Management category is the most appropriate classification for the Service Continuity Management and Capacity and Availability Management process areas.
C. The Process Management category is the most appropriate classification for the Organizational Service Management process area
D. The practices within the Service Continuity process area should build upon the practices within the Risk Management process area similar to the manner in which the Integrated Project Management process area builds upon maturity level 2 project management practices.
E. The Service System Development process area must be required for an organization to be a mature service organization.
F. The specific practices in the Service System Development process areas are presented with the appropriate rigor and detail for a mature service organization.
G. The Project Monitoring and Control process area adequately addresses service level management.
H. Material about the collection of customer satisfaction information is adequately covered as a specific practice in Organizational Service Management (an optional process area) and as informative material in the Service Delivery process area.
I. Maintenance found in the Service Delivery process area is adequately differentiated from product maintenance covered by CMMI-DEV.
J. The IPPD addition is as appropriate or as applicable for CMMI-SVC as it is for CMMI-DEV and should be added.
K. The Supplier Agreement Management process area is appropriate both for organizations with tangible products and service organizations with supplier agreements solely for services.
L. The Supplier Agreement Management process area should be required to reach maturity level 2 for service organizations with supplier agreements solely for services (as it is for organizations with suppliers of tangible products).

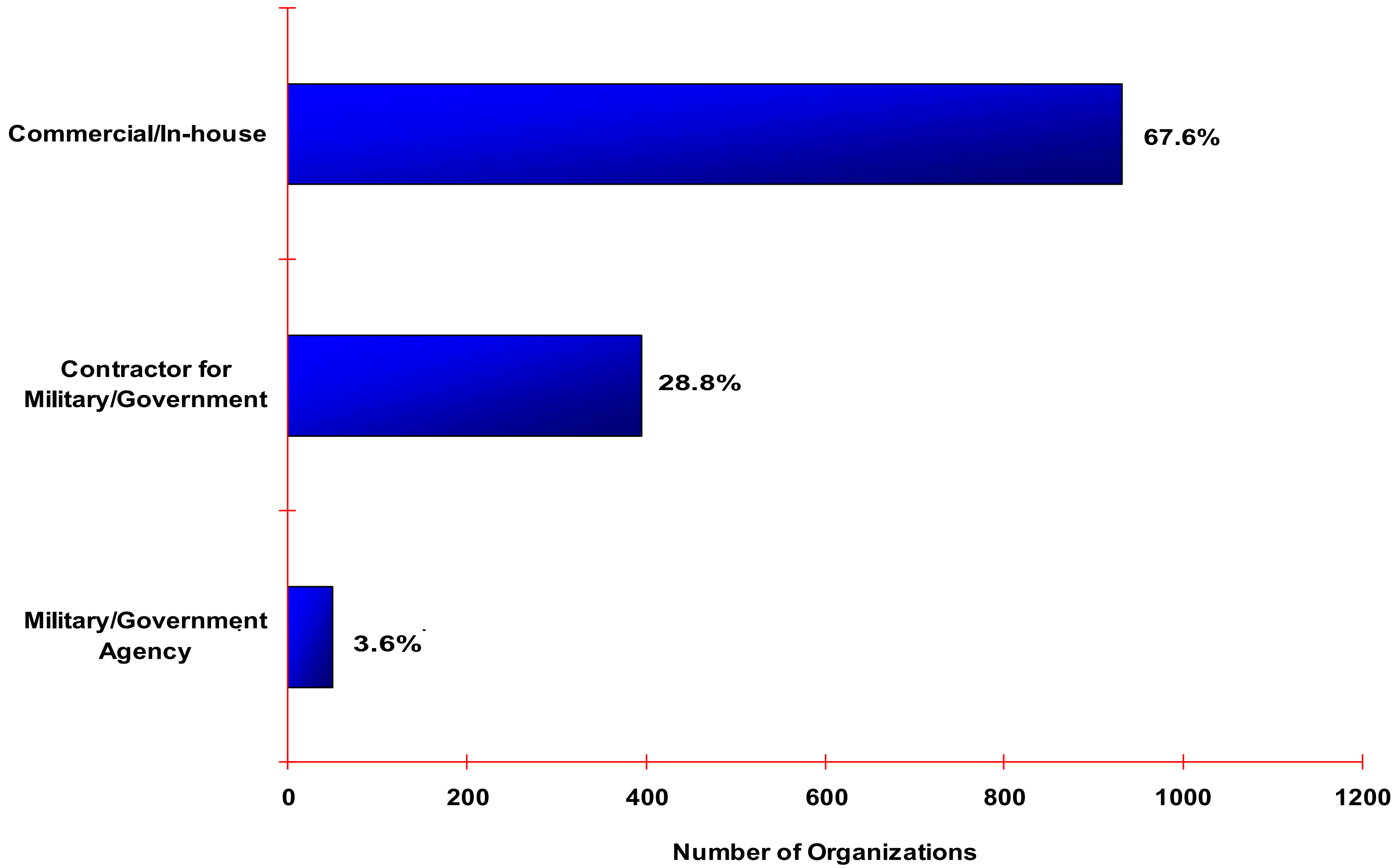
Process Area Survey Questions



e relationship between CMMI-SVC and ITIL?

- CMMI-SVC complements ITIL
  - Summarizes ITIL best practices into a small set of specific practices.
  - Reuses about 80% of the current CMMI model, allowing users to leverage their investments in development-based process training, improvements, and infrastructure to service-based offerings.
  - Provides an industry-accepted maturity model, helping organizations to plan and track their incremental progress toward high maturity.
  - Uses the same SCAMPI appraisal method that is used with the current CMMI model, allowing organizations to leverage appraisal expertise, preparation methods, and selected artifacts.

Who uses CMMs?



Courtesy of the SEI

Why do CMMs *really* matter?

Improvements	Median	Data Count	Low	High
Cost	34%	29	3%	87%
Schedule	50%	22	2%	95%
Productivity	61%	20	11%	329%
Quality	48%	34	2%	132%
Customer Satisfaction	14%	7	-4%	55%
ROI	4.0 : 1	22	1.7 : 1	27.7 : 1

Å N = 30, as of August 2006
Å Organizations with results expressed as change over time

Courtesy of the SEI

Implementing Acquisition and System Engineering Processes in a Maintenance Organization

Briefer: Mr. Bill Fetech
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The MITRE Corporation
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Agenda

- Cryptologic Systems Group (CPSG)
- Electronic Systems Center CMMI Focus
- CPSG CMMI Implementation
  - Process Guide
  - Implementation Guides
- CPSG CMMI Compliance
- CPSG Training

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ptologic Systems Group (CPSG)

Å Mission

ï *Ensuring Information Superiority and Agile Combat Support; Providing a Wide Range of Acquisition and Sustainment Services to the Warfighter — Through Teamwork, Innovation and Technological Excellence*

Å Organization

ï 800+ personnel

ï Lackland AFB (San Antonio), Texas

CPSG

- Programs
  - Air Force Public Key Infrastructure
  - Air Force Common Access Card (CAC)
  - Air Force cryptologic equipment depot and maintenance
  - Air Force Cryptographic Modernization Program Office

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CMMI Process Areas

Category	ESC Process Areas	
Project Management 	Risk Management	Technical Project Planning
Support 	Configuration Management Life-Cycle Logistics	Quality Assurance
Engineering 	Requirements Dev & Mngt Integrated Testing	Enterprise Integration System Safety
Process Management 	No process areas identified	

Red text ï New ESC process areas

C/EN Process Areas by Maturity Level

Process Areas	SP Level	GP Level	CMMI Focus
Enterprise Integration	2	2	Basic Project Management
Quality Assurance	2	2	
System Safety	2	2	
Technical Project Planning	2	2	
Life-Cycle Logistics	2	2	
Configuration Management	2	3	Process Standardization
Requirements Dev/Mngt	3	5	Continuous Process Improvement
Risk Management	2	5	
Integrated Testing	2	5	

ESC CMMI Support (Toolkits)

EN Process Improvement

PROCESS:
- CMMI In Depth
- Dictionary
- Acronyms

COMPLIANCE:
- Checklists
- Process

INFORMATION:
- Training
- Links

CONTACT US

Welcome to the EN Process Improvement Resource Center

Since 1998, a government-industry-Software Engineering Institute (SEI) collaboration has been under way to develop a product suite of models, training, and assessment methodology that support integrated process and product improvement across the enterprise. These products are intended to replace legacy maturity models,including SW-CMM and Electronics Industries Association Interim Standard (EIA/IS) 731, the Systems Engineering Capability Model (SECM) in December 2003.

Toolkits

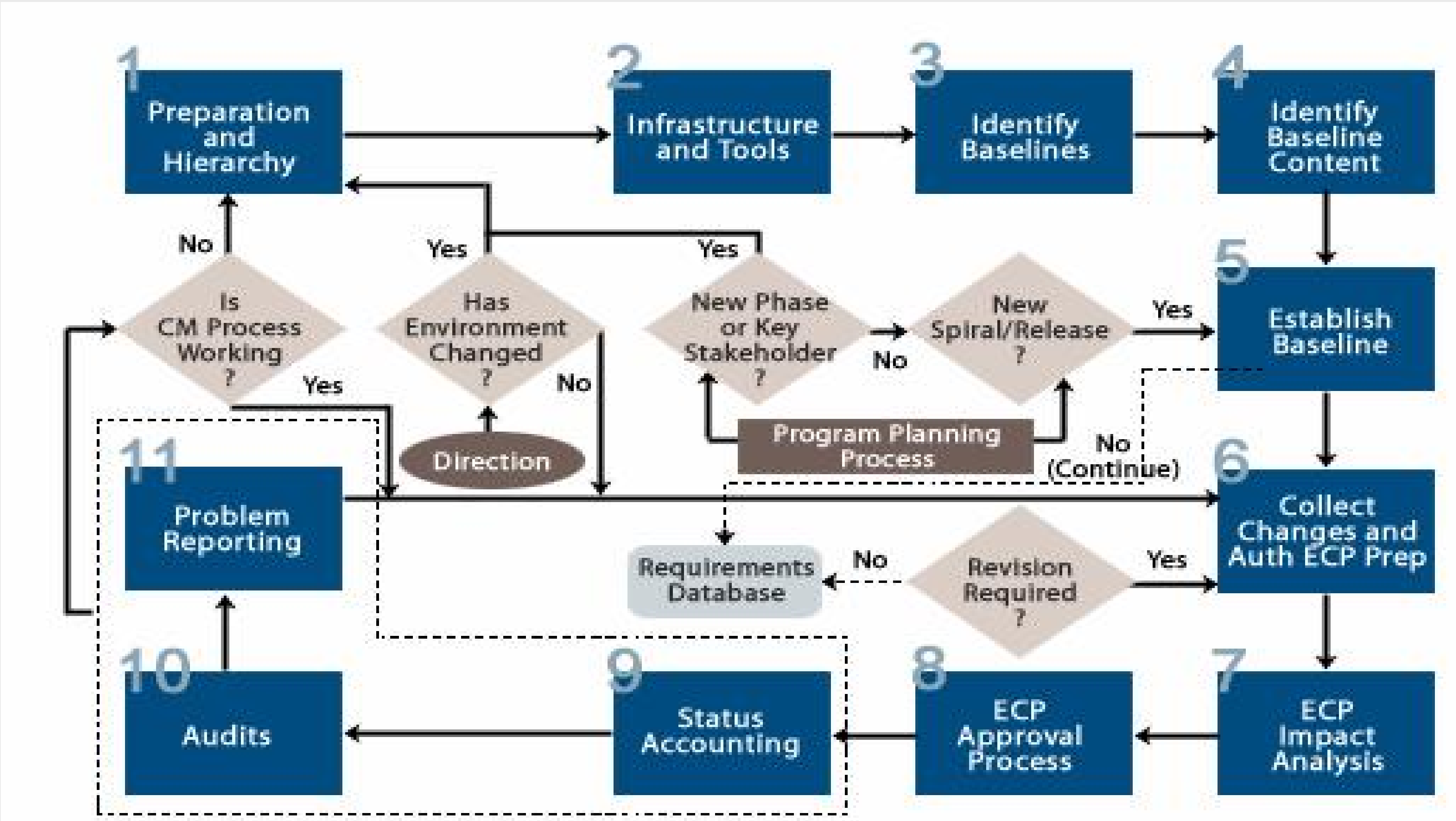
- Configuration Management Toolkit *
- Enterprise Integration Toolkit
- Integrated Testing Toolkit *
- Life-Cycle Logistics Toolkit
- Partnering Toolkit
- Quality Assurance Toolkit
- Requirements Process Toolkit*
- Risk Management Toolkit *
- System Safety Process Toolkit
- Technical Project Planning Toolkit

* CPSG Focus Areas

ESC Toolkits (Contents)

- Process Diagram
- Definitions
- Process Steps
  - Required
  - Optional
  - Suggested
- Tailoring Guidance
- Training
- Policies and References
- Tool Reviews
- Checklists
- Examples

ESC Toolkit
Configuration Management Process



ESC Toolkit
Step 1 - CM Process

1 Preparation and Hierarchy

ESC Major Step (required)

Action: Appoint an Enterprise Configuration Manager and Component System CMs and Develop Implementation Strategy

A Configuration Manager needs to be appointed for the program as well as a support team to handle the Integrated Digital Environment and any automated configuration management tools to be used on the program. An implementation strategy needs to be developed that addresses the requirements for the configuration management effort .

Sub Steps:
- **Strategy**
- **Hierarchy**
- **Control**
- **Stakeholders**
- **Buy-in**

ESC Actions (Optional)

C Tailoring Guidance

Required

The major steps are the goals of each process. All organizations are required to implement each process that achieves these goals.

Optional

The actions (e.g., 1a, 1b, etc) for each step are considered best practices and are expected to be performed by each organization to implement satisfactory processes. It is possible to satisfy the required goals without implementing the expected practices but the burden of proof is on the organization using an alternative set of practices.

Suggested

All material covered in the training sessions and resources provided in the toolkit are suggested approaches to implementing the expected practices. This material is optional and may be used at the discretion of the organization.

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PSG Process Areas

- Six Process Areas for Program Implementation
  - Life-Cycle Logistics
  - Technical Project Planning

PSG Process Guide

ÅAll Mandatory Steps from ESC Process Area

ÅSome ESC ñOptionalò and ñSuggestedò Steps are Mandatory CPSG Steps

ÅProcess Guide

- ï Contain the ñWhatò ï Required Steps
- ï No program tailoring allowed

iguration Management Process Guide

ESC Required Steps

…iguration Management Process Guide Example

CPSG Required Steps

ESC Required Steps

3.2. Configuration Management Practices

Using the ESC provided guidance, CPSG/EN has developed a Configuration Management Implementation Guide which provides additional guidance when developing a program specific CM process. The ten areas described below must be implemented.

3.2.1. Preparation and Hierarchy

In this area, each acquisition program, system, and end item is required to:

a. Appoint, in writing, a configuration manager

b. Develop a CM plan

c. Identify the configuration items (CI's)

d. Identify the internal and external stakeholders

e. Determine the CM structure and hierarchy

f. Establish a Configuration Control Board (CCB)

3.2.2. Infrastructure and Tools

In this area, each acquisition program, system, and end item is required to:

a. Identify tool requirements

b. Coordinate tool requirements with CPSG/EN

c. Train their CM workforce

d. Update CM information on ENWeb

Implementation Guides

Å Implementation Guides

- ï Contain the ñHowò
- ï Allowable program tailoring identified
- ï Templates provided for each process area
- ï Provide Program Managers/Lead Engineers with an ñ80%ò solution
- ï Ensure consistency across CPSG
- ï Example: Configuration Management Process

Plan Development and Tailoring Guidance

4.1.4 Determine Configuration Management Structure and Hierarchy

A government configuration management program needs to be established for each program to handle the user requirements, system requirements, and external interfaces. For each development contract awarded under the program, the contractor will probably be required to establish a configuration management program to handle the system requirements, allocated requirements, product requirements, and support requirements. Once the system is fielded, a sustainment configuration management program needs to be established. In a system of systems program or one involving multiple development contracts, a configuration management hierarchy must be established.

Implementation:

CM Plan Template: Configuration Management Organization

Tailoring Guidance:

This is always required, but the actual structure is left to the program.

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ESC/EN Web

ESC CMMI Process Areas

CPSG CMMI Responses

Requirements Development and Management	Level 2: Complete	Status: B	Updated: 30 Nov. 06
Configuration Management	Level 2: Complete	Status: B	Updated: 16 Nov. 06
Risk Management	Level 2: Complete	Status: B	Updated: 30 Nov. 06
Enterprise Integration	Level 2: 11 Mar. 07	Status: G	Updated: 30 Nov. 06
Integrated Testing	Level 2: 04 Feb. 07	Status: G	Updated: 30 Nov. 06
Technical Project Planning	Level 2: Complete	Status: B	Updated: 30 Nov. 06
Quality Assurance Process	Level 2: 04 Feb. 07	Status: G	Updated: 30 Nov. 06
System Safety Process	Level 2: 07 Jan. 07	Status: G	Updated: 30 Nov. 06
Life-Cycle Logistics	Level 2: Complete	Status: B	Updated: 06 Nov. 06

ESC CMMI (ENWeb) Generic Goals

ESC CMMI Generic Goals

Part II: Generic Practices

GG 1: Achieve Specific Goals

GP 1.1: Perform Development Base Practices	Lev: 2	Yes	
GP 1.2: Perform Management Base Practices	Lev: 2	Yes	

GG 2: Institutionalize a Managed Process

GG 2.1: For Requirements Development

GP 2.1.1: Establish an Organizational Policy	Lev: 2	No	28 Feb. 07
GP 2.1.2: Plan the Process	Lev: 2	Yes	
GP 2.1.3: Provide Resources	Lev: 2	Yes	
GP 2.1.4: Assign Responsibility	Lev: 2	Yes	
GP 2.1.5: Train People	Lev: 2	Yes	
GP 2.1.6: Manage Configurations	Lev: 2	No	28 Feb. 07
GP 2.1.7: Identify and Involve Relevant Stakeholders	Lev: 2	Partial	31 Jan. 07
GP 2.1.8: Monitor and Control the Process	Lev: 2	Yes	
GP 2.1.9: Objectively Evaluate Adherence	Lev: 2	No	01 Jun. 07
GP 2.1.10: Review Status with Higher-Level Management	Lev: 2	No	01 Mar. 07
GP 2.1.11: Perform Base Practices	Lev: 2	No	01 Jun. 07

ESC CMMI (ENWeb) Requirements Process Specific Goals

ESC CMMI Specific Goals

Requirements Development and Management — Level 2: 01 Jun. 07 — Status: G

Question		Answer	Planned Date	Status	
Part I: Specific Practices					
SG 1: Develop Customer Requirements					
SP 1.1: Collect Stakeholder Needs	Lev: 2	Yes		G	Edit
SP 1.2: Transform Stakeholder Needs, Expectations, Constraints, and Interfaces into Customer Requirements	Lev: 2	Yes		G	Edit
SP 1.3: Elicit Needs	Lev: 2	Yes		G	Edit
SG 2: Develop Product Requirements					
SP 2.1: Establish Product and Product Component Requirements	Lev: 2	Yes		G	Edit
SP 2.2: Allocate Product Component Requirements	Lev: 2	Yes		G	Edit
SP 2.3: Identify Interface Requirements	Lev: 2	Yes		G	Edit

ESC/EN Web

Corporate Process Areas

CPSG CMMI Responses

Requirements Development and Management	Level 2: Complete	Status: B	Updated: 30 Nov. 06
Configuration Management	Level 2: Complete	Status: B	Updated: 16 Nov. 06
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Life-Cycle Logistics	Level 2: Complete	Status: B	Updated: 06 Nov. 06

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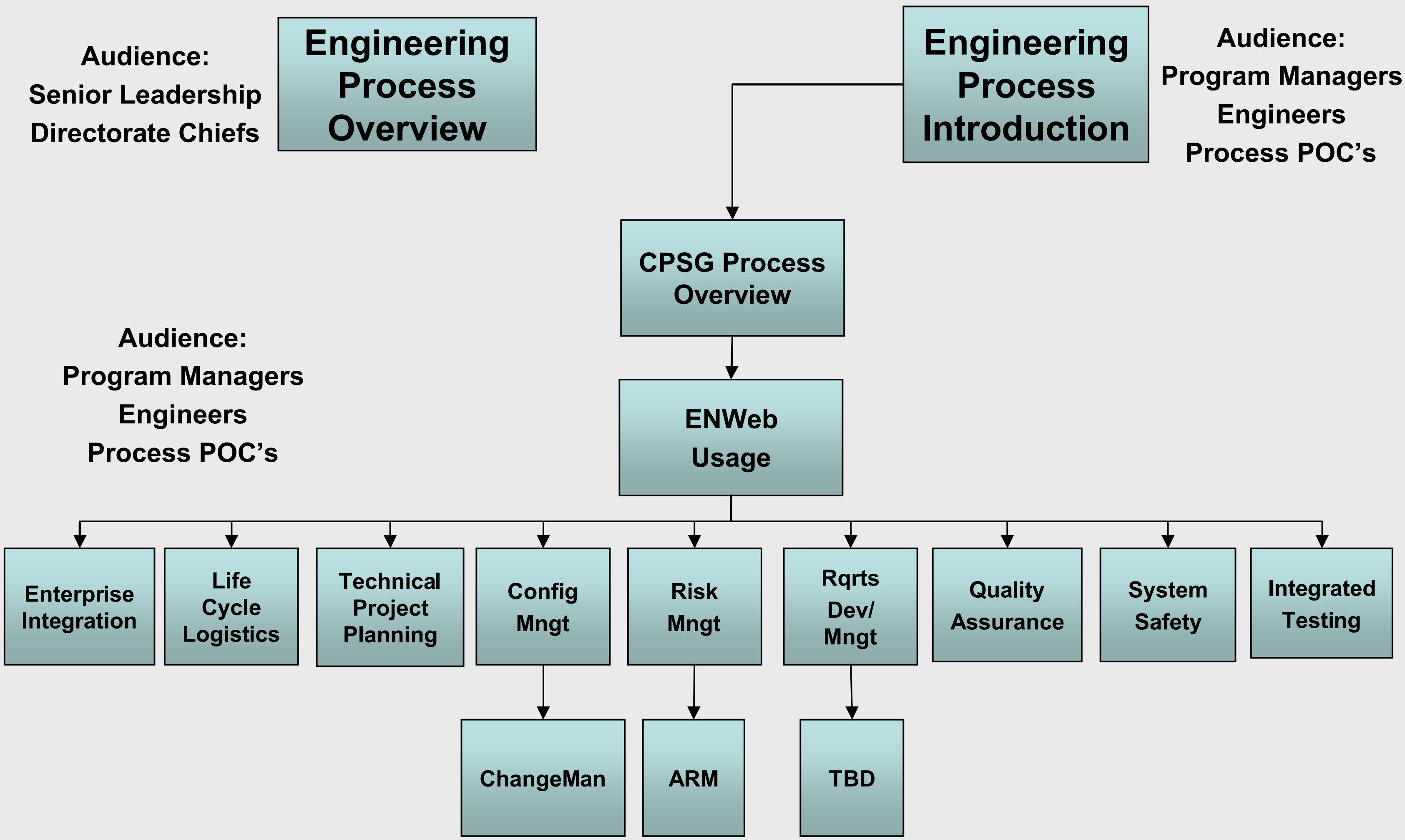
Training Plan



Wrap - Up

ÅCryptologic Systems G... up (CPSG)

ÅElectronic Systems ... CMMI Focus

ÅCPSG CMMI Impl... tion

ï Process Guide...

ï Implement... es

ÅCPSG C... mpliance

ÅCPSG T... ing

Any Questions?

hank You for Your Time

*Source ï MITRE ï Mike Bloom